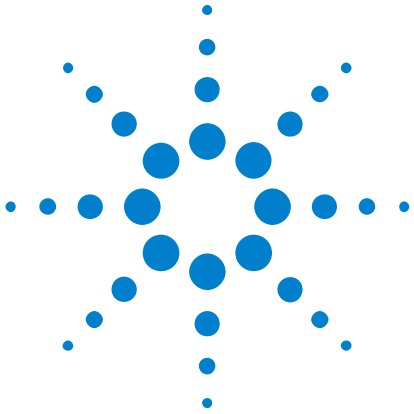

DSOX4USBSQ USB 2.0 Signal Quality Analysis Application

Electrical Testing Notes

Agilent Technologies

Notices

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USB 2.0 Signal Analysis—At a Glance

The DSOX4USBSQ USB 2.0 Signal Quality Analysis application for the InfiniiVision 4000 X-Series oscilloscopes supports two use models:

- You can quickly test USB signal quality in-circuit with real-world packets. In this case:
  - You can use test fixtures as an easy way to probe signals.
  - The USBSQ analysis application's Auto Setups may need to be adjusted before analyzing real-world packets.
- You can verify signal quality to USB 2.0 compliance specifications. In this case:
  - You must use the test fixtures, equipment, and test setups required by the USB Implementers Forum (USB-IF).
  - The USBSQ analysis application's Auto Setups should work as is for the required test packets.

The signal quality analysis application:

- Lets you select Hi-Speed, Full Speed, or Low Speed tests for Devices and Hosts. Hubs can be tested by running both device and hosts tests against the hub.
- Runs all the signal quality tests for the selected speed and device type combination.
- Automatically sets up the oscilloscope for the selected tests.
- Provides detailed results information for each test that has been run.
- Lets you save the detailed results information to an HTML report.

In This Book

This manual contains notes on the electrical tests that are performed by the DSOX4USBSQ USB 2.0 Signal Quality Analysis application; it describes the equipment used and how the tests are performed. It has these chapters:

- Chapter 1, “Preparing for Signal Quality Analysis,” starting on page 7
- Chapter 2, “Device Signal Quality Testing,” starting on page 19
- Chapter 3, “Host Signal Quality Testing,” starting on page 39
- Chapter 4, “Hub Upstream Signal Quality Testing,” starting on page 53
- Chapter 5, “Hub Downstream Signal Quality Testing,” starting on page 65
- Chapter 6, “Saving Test Results to an HTML File,” starting on page 81
- Appendix A, “Probing Hi-Speed Signals with InfiniiMode Using SQiDD as a Feedthrough,” starting on page 83

See Also

- The USB 2.0 developers documents are available at the USB Implementers Forum web site, "http://www.usb.org/developers/docs".

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This chapter describes the equipment and software required for performing signal quality analysis with the 4000 X-Series oscilloscope and the DSOX4USBSQ USB 2.0 Signal Quality Analysis application.

Oscilloscope Requirements

The DSOX4USBSQ USB 2.0 Signal Quality Analysis application requires an Agilent InfiniiVision 4000 X-Series oscilloscope, firmware version 3.10 or later.

For Hi-Speed Tests

Hi-Speed tests require a 1.5 GHz bandwidth model oscilloscope.

Hi-Speed tests on a 2-channel oscilloscope with single-ended SMA cable connections is not supported because the sample rate will not meet the 5 GSa/s rate that is required. Using a differential probe on a 2-channel oscilloscope works fine.

For Full and Low Speed Tests

Full and Low Speed tests can be performed with 200 MHz, 350 MHz, 500 MHz, 1 GHz, or 1.5 GHz bandwidth model oscilloscopes.

Full Speed testing is best on a 4-channel oscilloscope because when using a 2-channel oscilloscope, channels 1 and 2 are non-interleaved and the sample rate will be below the 4 GSa/s that the USB-IF testing procedures require. If Full Speed tests are run on a 2-channel oscilloscope, interpolation is used on the data.

For Optional USB 2.0 Triggering and Decode in the Oscilloscope

The optional DSOX4USBH and DSOX4USBFL products (for USB 2.0 Hi-Speed and Full/Low-Speed triggering and decode, respectively) can be very useful tools for identifying and triggering on packets that you might want to run the USB signal quality tests on.

Fixtures for Signal Quality Tests

Two different fixtures are used for Hi-Speed tests; one is for devices and other is for hosts. See “Fixtures for Hi-Speed Signal Quality Tests" on page 9.

One fixture is used for Full and Low Speed tests. See “Fixture for Full/Low Speed Signal Quality Tests" on page 10.

Fixtures for Hi-Speed Signal Quality Tests

Hi-Speed testing requires one of these test fixtures:

- Device Hi-Speed Signal Quality Test Fixture, part number E2649-66401.

This fixture can be ordered using the Agilent part number E2649-60001, which includes two RF SMA (m) vertical 50-ohm termination connectors and two 4 inch USB A-to-B cables (E2646-61601).

- Host Hi-Speed Signal Quality Test Fixture, part number E2649-66402.

This fixture can be ordered using the Agilent part number E2649-60002, which includes two RF SMA (m) vertical 50-ohm termination connectors and two 4 inch USB A-to-B cables (E2646-61601).

These Hi-Speed Signal Quality test fixtures are powered by a 5 V power supply, which can be ordered using Agilent part number 0950-2546. Equivalent power supplies can also be used.

NOTE The Hi-Speed fixture part numbers E2649-66401 and E2649-66402 are provided for identification purposes only and cannot be used for ordering.

Older Versions of the Hi-Speed Signal Quality Test Fixtures

Older versions of the Hi-Speed signal quality test fixtures exist and may be used:

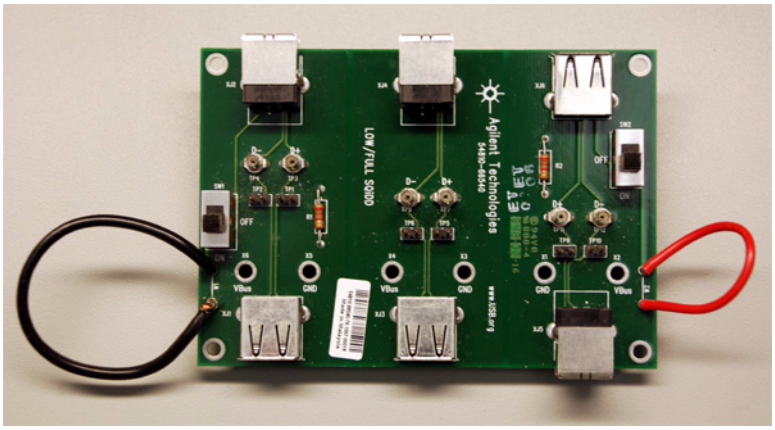
- Device Hi-Speed Signal Quality Test Fixture, part number E2645-66507.
- Host Hi-Speed Signal Quality Test Fixture, part number E2645-66508.

When using these older fixtures with the 1131A, 1133A, or 1134A InfiniiMax differential probes, you also need the Agilent header adapter, part number 01131-68703. This header adapter is included with E2669A and E2678A (purchased after October 2003).

Fixture for Full/Low Speed Signal Quality Tests

Full and Low Speed testing require this test fixture:

- E2646A/B SQiDD board test fixture.



This fixture can be ordered using the model number E2646A/B.

Probe Requirements

Hi-Speed tests require a differential probe (see "Differential Probe Connection for Hi-Speed Signal Quality Tests" on page 12) or two single-ended SMA cable connections (see "Single-Ended SMA Cable Connection for Hi-Speed Signal Quality Tests" on page 13).

Low and Full Speed host tests require single-ended probes (see "Single-Ended Probe Connection for Full/Low Speed Signal Quality Tests" on page 14).

Differential Probe Connection for Hi-Speed Signal Quality Tests

NOTE

The N2750A Series InfiniiMode probes cannot be used with the Hi-Speed Signal Quality test fixtures because they have damping resistors and the USB test fixture also has damping resistors specifically designed for the E2678A socketed probe heads.

However, if you are not verifying signal quality to USB 2.0 specifications (in other words, you are testing USB signal quality in-circuit with real-world packets), and you just need a feed-through that will let you probe Hi-Speed signals, you can use the E2646A/B SQiDD test fixture (normally used for Full and Low Speed testing) and InfiniiMode probes. See Appendix A, "Probing Hi-Speed Signals with InfiniiMode Using SQiDD as a Feedthrough," starting on page 83.

When using a differential probe connection for Hi-Speed signal quality tests, Agilent recommends the 1131A, 1133A, or 1134A InfiniiMax differential probes and the E2678A socketed probe head or the E2669A differential connectivity kit.

When setting up the Agilent 113xA differential probe for connection to the Hi-Speed signal quality test fixture:

- Attach the socketed probe head to the differential probe amplifier.
- Handle the socketed probe head and header adapter carefully.
- For durability, epoxy can be used to strengthen the assembly. Only apply epoxy to back (noncomponent) side of probe head.

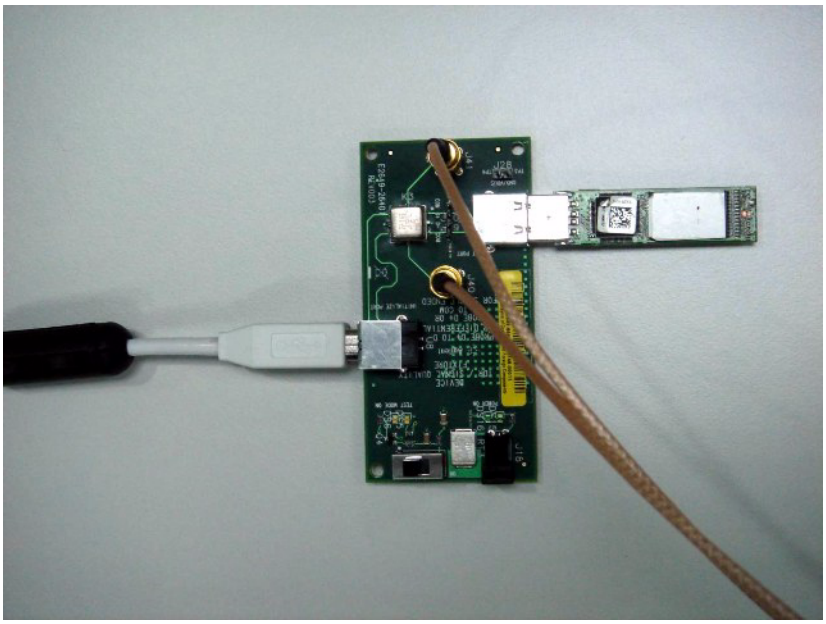
Figure 1 Differential Probe Setup

NOTE

In certain test situations, there may not be a ground connection between the oscilloscope and the device under test (DUT). This may lead to the signal seen by the differential probe to be modulated up and down due to the mid-frequency switching power supply. Connecting the oscilloscope ground to the DUT ground will be required to establish a common ground reference.

Single-Ended SMA Cable Connection for Hi-Speed Signal Quality Tests

The Hi-Speed signal quality test fixtures have SMA connectors for probing with SMA cables.



Single-Ended Probe Connection for Full/Low Speed Signal Quality Tests

Low and Full Speed host tests require two single-ended probes.

Low and Full Speed device tests require three single-ended probes — the third probe is for the adjacent D-/D+ signal.

The passive probes that are included with the oscilloscope are sufficient.

Miscellaneous Cables and Devices

The following table lists miscellaneous cables and devices required for certain tests.

Table 1 Miscellaneous Cables and Devices

Equipment Required	Tests and Quantities			
	Host Hi-Speed	**Hub Hi-Speed**	**Device Hi-Speed**	**Low/Full Speed**
5 m USB cable (any listed on USB-IF web site).	1	1	1	as needed
1.5 m USB cable (any listed on USB-IF web site).	1	1	n/a	n/a
1 m USB cable (any listed on USB-IF web site).	n/a	n/a	n/a	as needed
Modular AC power cord.	2	2	2	n/a
Hi-Speed USB Hub (any listed on USB-IF web site).	1	n/a	n/a	n/a
Hi-Speed USB Device (any listed on USB-IF web site).	1	n/a	n/a	n/a
USB self-powered hub (and power supply). These are the hubs used for compliance testing and are available from the USB-IF. For development testing, in most cases, a hub that has passed USB compliance testing can be used.	n/a	n/a	n/a	5

Additional Equipment and Set Up for Signal Quality Compliance Testing

When performing USB 2.0 signal quality compliance testing (instead of testing the signal quality of real-world packets):

- You need a high-speed electrical test bed computer and the High-Speed Electrical Test Tool Kit software (USBHSET) in order to generate compliance test packets. See "High-Speed Electrical Test Bed Computer" on page 16.
- See also: "Additional Set Up for Signal Quality Compliance Testing" on page 17.

High-Speed Electrical Test Bed Computer

The high-speed electrical test bed computer hosts a USB 2.0 compliance host controller for hi-speed hub or device electrical test, or serves as a test bed host for a USB 2.0 host controller under test. For instructions on configuring this computer, refer to the High-Speed Electrical Test Toolkit Setup Instruction document which comes with the "High-Speed Electrical Test Tool Kit Software" on page 16.

Table 2 High-Speed Electrical Test Bed Computer

Equipment Required	Tests and Quantities			
	Host Hi-Speed	Hub Hi-Speed	Device Hi-Speed	Low/Full Speed
High-Speed Electrical Test Bed Computer	1	1	1	1
High-Speed Electrical Test Tool Kit software (USBHSET)	1	1	1	1

High-Speed Electrical Test Tool Kit Software

You can download the High-Speed Electrical Test Tool Kit software (USBHSET) from the developers tools page at the USB Implementers Forum web site, "http://www.usb.org/developers/tools".

The High-Speed Electrical Test Tool Kit software contains and uses a proprietary EHCI driver stack. The use of this proprietary EHCI driver stack facilitates the electrical testing that requires direct control of the command registers of the USB EHCI host controllers. The end result is a much more robust test bed environment.

Because the proprietary EHCI driver stack is designed for debug and test validation purposes, this driver stack does not support the normal functionality as found in the EHCI drivers from Microsoft (or the device

vendor). Therefore, an automatic driver stack switching function has been implemented into the Hi-speed Electrical Test Tool for easy switching between the proprietary EHCI driver stack and that from Microsoft.

Upon invocation of the HS Electrical Test Tool software, the driver stack will automatically switch to the Intel proprietary EHCI driver stack.

Upon exit of the HS Electrical Test Tool software, the driver stack will automatically switch to the Microsoft EHCI driver stack.

Additional Set Up for Signal Quality Compliance Testing

When performing USB 2.0 signal quality compliance testing (instead of testing the signal quality of real-world packets), be sure to take these additional set up steps:

1. Turn on the oscilloscope to allow 30 minutes of warm up time prior to use.
2. When performing signal quality compliance testing, if the ambient temperature has changed more than 5 degrees from the previous calibration, perform the user calibration procedure built into the oscilloscope.
3. Compensate the passive probes (see the oscilloscope *user's guide*).
4. Calibrate all the probes.

1 Preparing for Signal Quality Analysis

2 Device Signal Quality Testing

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Device Hi-Speed Signal Quality Test

Table 3 Equipment Used in Device Hi-Speed Signal Quality Tests

Quantity	Item	Description/Model
1	Oscilloscope	Agilent 4000 X-Series 1.5 GHz bandwidth model
1	Oscilloscope probing solution:	
	• Differential probe	Agilent 113xA with E2678A or E2669A
	• SMA cables	Agilent 15443A matched cable pair or equivalent
1	Host test bed computer	Any computer with the Windows XP, Windows 7, or Windows 8 operating system and hi-speed USB ports.
1	Device Hi-Speed Signal Quality test fixture and 4" USB cable	Agilent E2649-66401
1	5V power supply	Agilent 0950-2546 or equivalent

To set up and run the Device Hi-Speed signal quality tests:

1 Connect the USB Device, test fixtures, and equipment:
   - If you are probing the test fixture using a differential probe, see "Device Hi-Speed Connection - Differential Probe" on page 24.
   - If you are probing the test fixture using SMA cables, see "Device Hi-Speed Connection - SMA Cables" on page 25.

2 Set up the test signal/packet that will be analyzed.

   To set up the test packets used for compliance testing, see "Device Hi-Speed Compliance Test Packets" on page 26.

3 On the Device Hi-Speed Signal Quality test fixture, place the TEST switch (S1) in the ON position.

   Verify the yellow TEST LED is lit.

4 On the oscilloscope's front panel, press the **[Analyze]** key.

5 In the Analyze Menu, press the **Features** softkey; then, select **USB Signal Quality**.

6 Press the **Test** softkey and select the **Device Hi-Speed Signal Quality** test.

7 Press the **Signals** softkey. In the USB Signal Quality Signals Menu:

   a Press the **Test Connection** softkey and select whether you are using a **Single-ended** (with SMA cables) or **Differential** probe connection.

   b If you are using a differential connection, press the **Source** softkey and select the analog input source channel connected to the differential probe.

      If you are using a single-ended (SMA cables) connection, press the **DP SMA** softkey and select the analog input source channel connected to the D+ signal. Then, press the **DN SMA** softkey and select the analog input source channel connected to the D- signal.

      On 4-channel oscilloscopes, you are forced to use different channel pairs for the D+ and D- signals. This provides the maximum sample rate. (Channels 1 and 2 are one pair and channels 3 and 4 are the other pair.)

      Hi-Speed tests using single-ended SMA cable connections are not supported on 2-channel oscilloscopes because the sample rate does not meet the required 5 GSa/s.

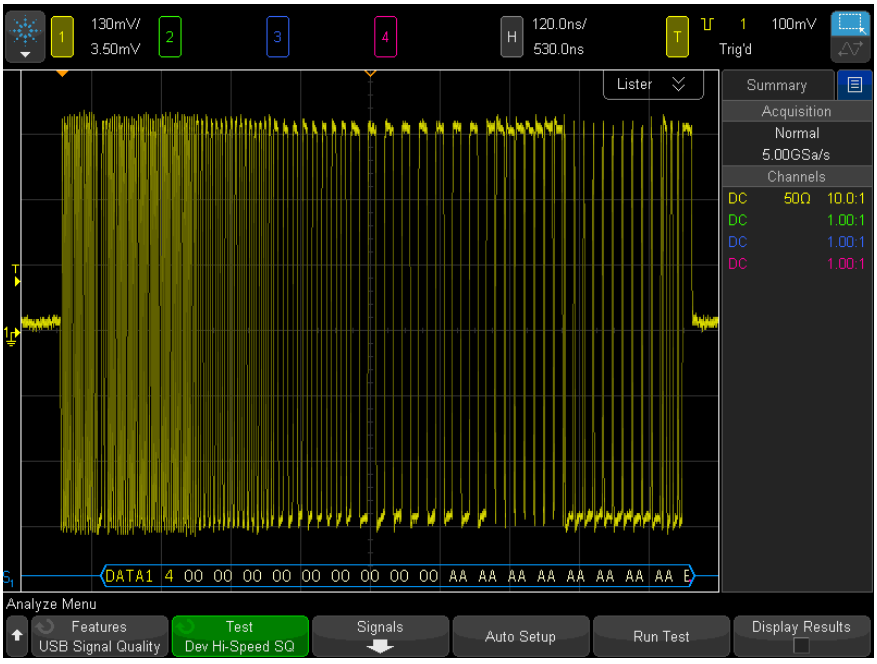
   c Press the **Test Type** softkey and select **Near-end** or **Far-end**.

      The terms "near-end" and "far-end" are based on which end of the cable the test fixture is attached in relation to the device being tested. The point where measurements are made dictates what eye template is used.

8 Press the **Auto Setup** softkey to automatically set up the oscilloscope for the selected test.

   For optimal test results, you can make adjustments to the auto setup. Generally, you want one packet of data, plus the time of one bit on each end, across the oscilloscope's display. Also, vertical scale and offset should be adjusted so that the signals take six vertical divisions without being clipped.

   You should see the transmitted test packet on the oscilloscope as below.

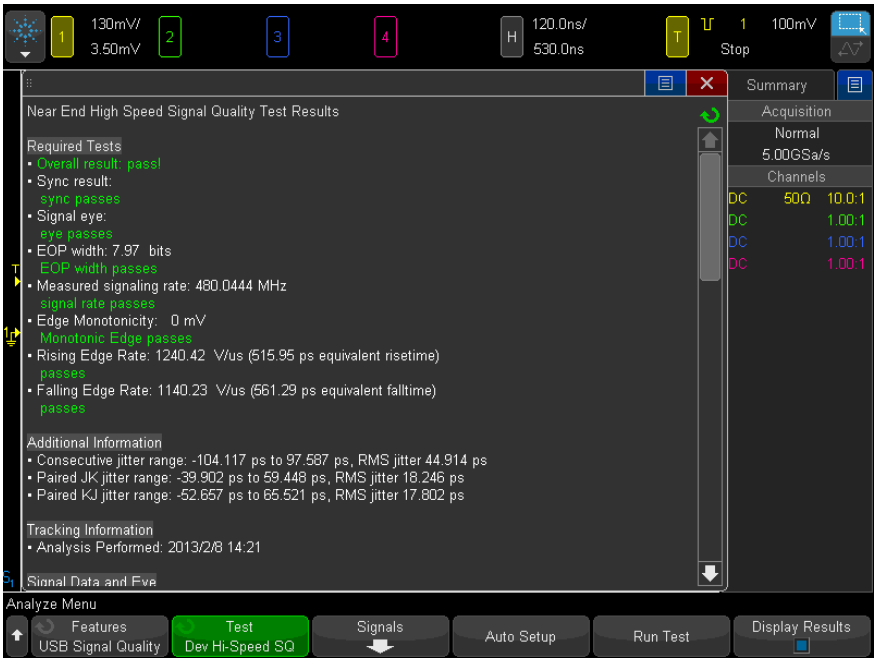


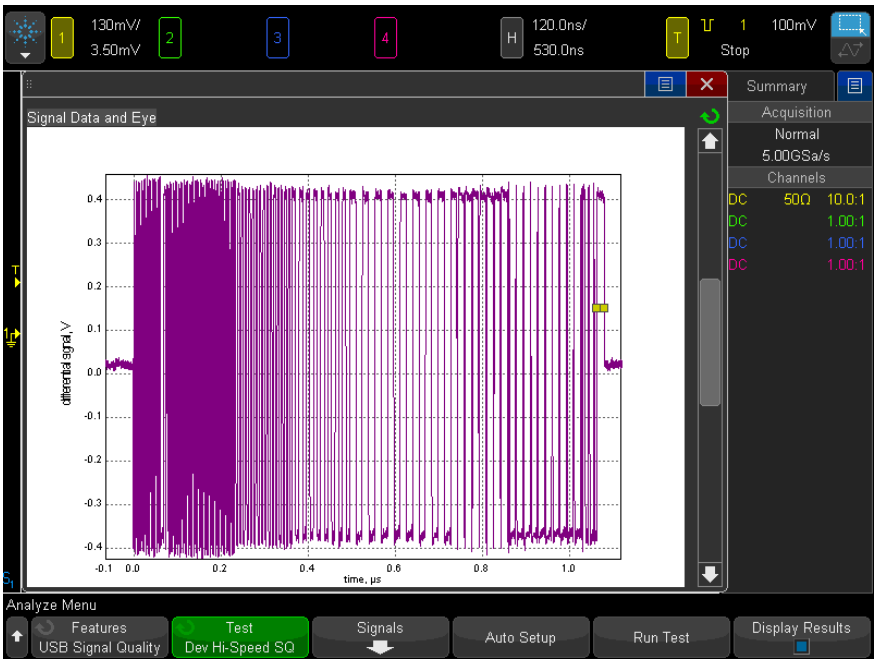
9 Press the **Run Test** softkey to run the selected signal quality test.

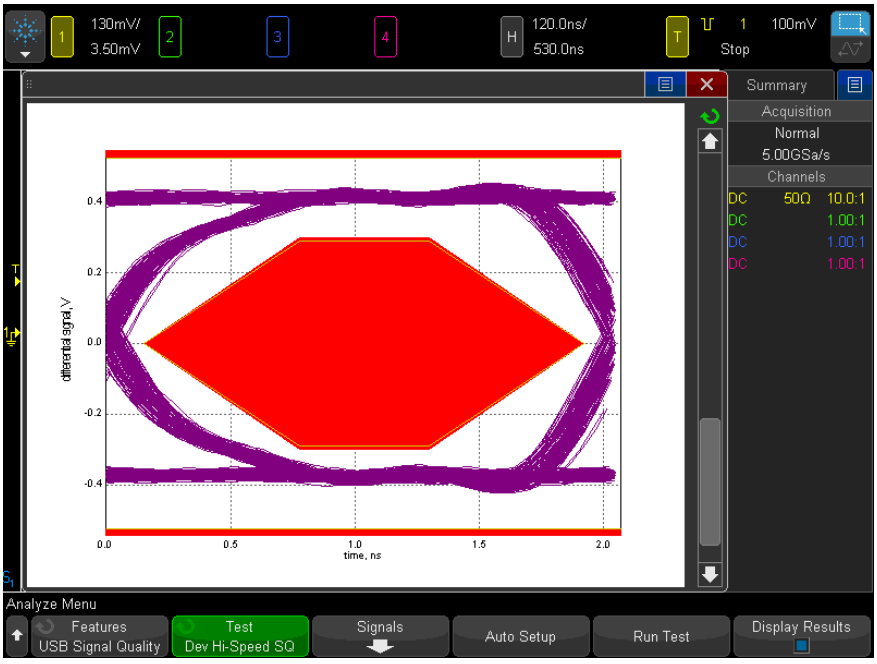
When tests are run, the oscilloscope stops acquisitions if they are running, analyzes the data on screen, and then displays the results.

NOTE Tests can take several minutes to run and cannot be cancelled once started.

When the test completes, the results are automatically displayed. You can press the **Display Results** softkey to disable or reenable the test results display.


130mV/
3.50mV
120.0ns/
530.0ns
100mV
Stop
Summary
Near End High Speed Signal Quality Test Results
Required Tests
• Overall result: pass!
• Sync result:
sync passes
• Signal eye:
eye passes
• EOP width: 7.97 bits
EOP width passes
• Measured signaling rate: 480.0444 MHz
signal rate passes
• Edge Monotonicity: 0 mV
Monotonic Edge passes
• Rising Edge Rate: 1240.42 V/us (515.95 ps equivalent risetime)
passes
• Falling Edge Rate: 1140.23 V/us (561.29 ps equivalent falltime)
passes
Additional Information
• Consecutive jitter range: -104.117 ps to 97.587 ps, RMS jitter 44.914 ps
• Paired JK jitter range: -39.902 ps to 59.448 ps, RMS jitter 18.246 ps
• Paired KJ jitter range: -52.657 ps to 65.521 ps, RMS jitter 17.802 ps
Tracking Information
• Analysis Performed: 2013/2/8 14:21
Signal Data and Eye
Acquisition
Normal
5.00GSa/s
Channels
DC 50Ω 10.0:1
DC 1.00:1
DC 1.00:1
DC 1.00:1
Analyze Menu
Features
USB Signal Quality
Test
Dev Hi-Speed SQ
Signals
Auto Setup
Run Test
Display Results


130mV/
3.50mV
120.0ns/
530.0ns
100mV
Stop
Summary
Signal Data and Eye
differential signal, V
time, µs
Acquisition
Normal
5.00GSa/s
Channels
DC 50Ω 10.0:1
DC 1.00:1
DC 1.00:1
DC 1.00:1
Analyze Menu
Features
USB Signal Quality
Test
Dev Hi-Speed SQ
Signals
Auto Setup
Run Test
Display Results



The analyzed acquisition remains on screen and can be viewed by moving or dismissing the results dialog box.

You can run tests when the oscilloscope is already stopped. This is useful in the case of embedded hosts (and other cases) where the device under test (DUT) may not easily be placed in a test mode, and you want to analyze already acquired data.

See Also

- Chapter 6, “Saving Test Results to an HTML File,” starting on page 81

Device Hi-Speed Connection - Differential Probe

Perform these connection steps:

1. Attach the 5V power supply to J5 of the E2649-66401 Device Hi-Speed signal quality test fixture.

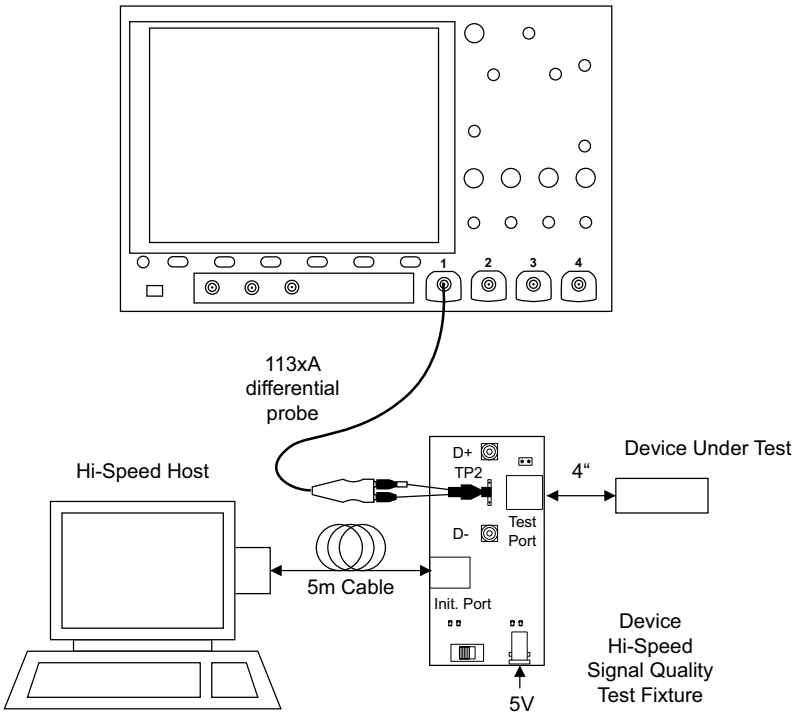
   Leave the TEST switch at the OFF position.

   Verify the green POWER LED is lit and the yellow TEST LED is not lit.

2. Connect the [TEST PORT] of the Device Hi-speed Signal Quality test fixture into the upstream facing port of the device under test, using the 4" USB cable.
3. Connect the [INIT PORT] of the test fixture to a Hi-speed capable port of the Test Bed Computer, using a USB cable.
4. Apply power to the device.

5 Attach the differential probe to D+/D- of TP2 on the test fixture. Ensure the + polarity on the probe lines up with D+.

6 Please terminate the fixture's SMA connectors with 50 Ohm terminators.



Device Hi-Speed Connection - SMA Cables

1 Attach the 5V power supply to J5 of the E2649-66401 Device Hi-Speed signal quality test fixture.

Leave the TEST switch at the OFF position.

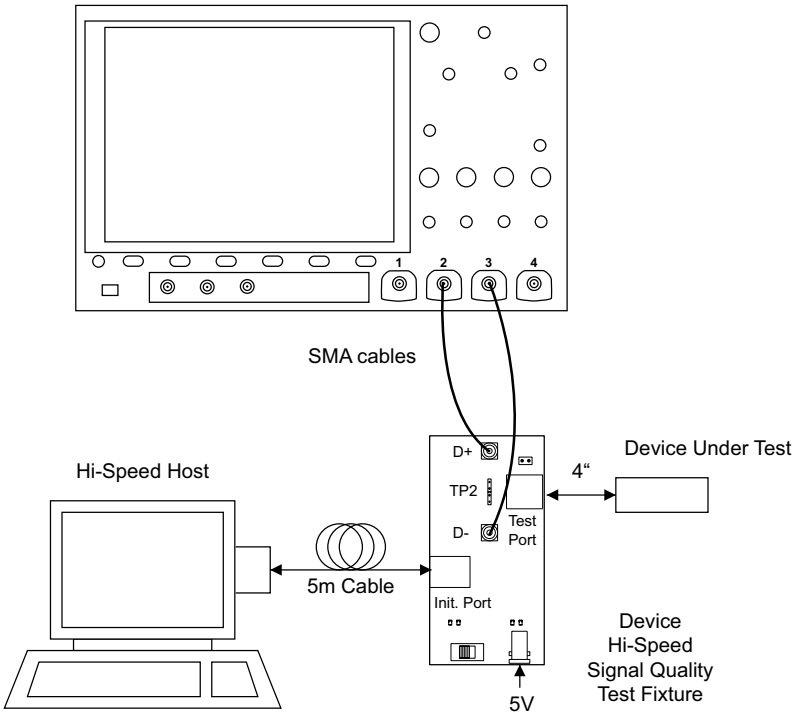
Verify the green POWER LED is lit and the yellow TEST LED is not lit.

2 Connect the [TEST PORT] of the Device Hi-speed Signal Quality test fixture into the upstream facing port of the device under test, using the 4" USB cable.

3 Connect the [INIT PORT] of the test fixture to a Hi-speed capable port of the Test Bed Computer, using the 5 meter USB cable.

4 Apply power to the device.

5 Attach the SMA cables to the SMA connectors D+ and D- on the test fixture.

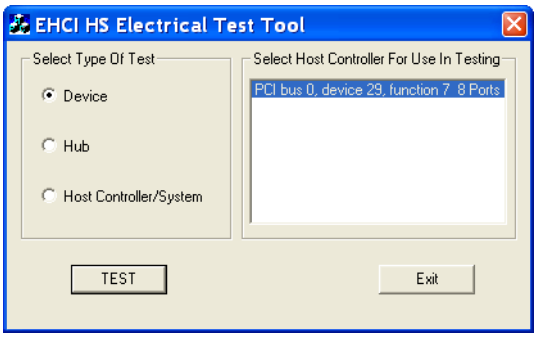


Device Hi-Speed Compliance Test Packets

To set up the Host computer to transmit compliance test packets, perform these steps:

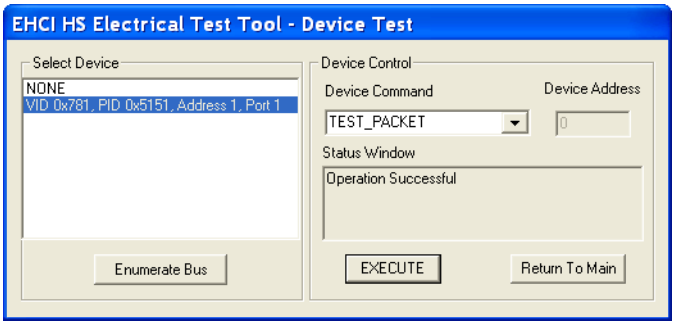
1 Invoke the HS Electrical Test Tool software on the Hi-Speed Electrical Test Bed computer.

2 Select **Device** and click the **TEST** button to open the Device Test dialog box.



3 In the Device Test dialog box, the device under test should be enumerated with the device's VID shown together with the root port in which it is connected.

4 Select **TEST_PACKET** from the **Device Command** drop down menu, and click **EXECUTE**. This forces the device under test to continuously transmit test packets.



Device Full Speed Signal Quality Test

Table 4 Equipment Used in Upstream Full Speed Signal Quality Test

Quantity	Item	Description/Model
1	Oscilloscope	Agilent 4000 X-Series
3	Passive probes	Probes included with the oscilloscope are sufficient.
1	Host test bed computer	Any computer with the Windows XP, Windows 7, or Windows 8 operating system and hi-speed USB ports.
1	SQiDD board	Agilent E2646A/B
1	full speed USB device	Intel Create and Share USB camera, P/N 735147-001, Model #: CS330
5	USB self-powered hubs	Any listed on USB-IF web site
6	5 meter USB cables	Any listed on USB-IF web site

To set up and run the Device Full Speed signal quality tests:

1 Connect the USB Device, test fixtures, and equipment. See "Device Full Speed Connection" on page 30.

2 Set up the test signal/packet that will be analyzed.

   To set up the test packets used for compliance testing, see "Device Full Speed Compliance Test Packets" on page 31.

3 On the oscilloscope's front panel, press the **[Analyze]** key.

4 In the Analyze Menu, press the **Features** softkey; then, select **USB Signal Quality**.

5 Press the **Test** softkey and select the **Device Full Speed Signal Quality** test.

6 Press the **Signals** softkey. In the USB Signal Quality Signals Menu:

   a Press the **D+ Source** softkey and select the analog input source channel connected to the D+ signal (channel 2 in the previous connection instructions).

   b Press the **D- Source** softkey and select the analog input source channel connected to the D- signal (channel 3 in the previous connection instructions).

      On 4-channel oscilloscopes, you are forced to use different channel pairs for the D+ and D- signals. This provides the maximum sample rate. (Channels 1 and 2 are one pair and channels 3 and 4 are the other pair.)

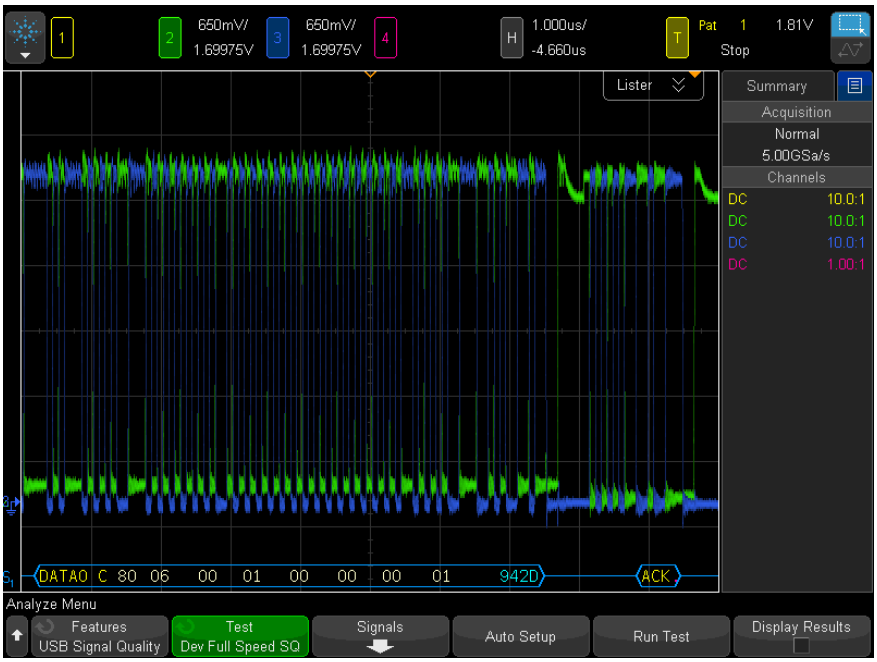
When full speed tests are run on a 2-channel oscilloscope, a statement about the analysis data being under-sampled will be included in the test results.

c Press the **Adj D+ Source** softkey and select the analog input source channel connected to the adjacent D+ signal (channel 1 in the previous connection instructions).

7 Press the **Auto Setup** softkey to automatically set up the oscilloscope for the selected test.

For optimal test results, you can make adjustments to the auto setup. Generally, you want one packet of data, plus the time of one bit on each end, across the oscilloscope's display. Also, vertical scale and offset should be adjusted so that the signals take six vertical divisions without being clipped.

You should see the transmitted test packet on the oscilloscope as below.



8 Press the **Run Test** softkey to run the selected signal quality test.

When tests are run, the oscilloscope stops acquisitions if they are running, analyzes the data on screen, and then displays the results.

NOTE Tests can take several minutes to run and cannot be cancelled once started.

When the test completes, the results are automatically displayed. You can press the **Display Results** softkey to disable or reenable the test results display.

The analyzed acquisition remains on screen and can be viewed by moving or dismissing the results dialog box.

You can run tests when the oscilloscope is already stopped. This is useful in the case of embedded hosts (and other cases) where the device under test (DUT) may not easily be placed in a test mode, and you want to analyze already acquired data.

See Also
- Chapter 6, “Saving Test Results to an HTML File,” starting on page 81

Device Full Speed Connection

Perform these connection steps:

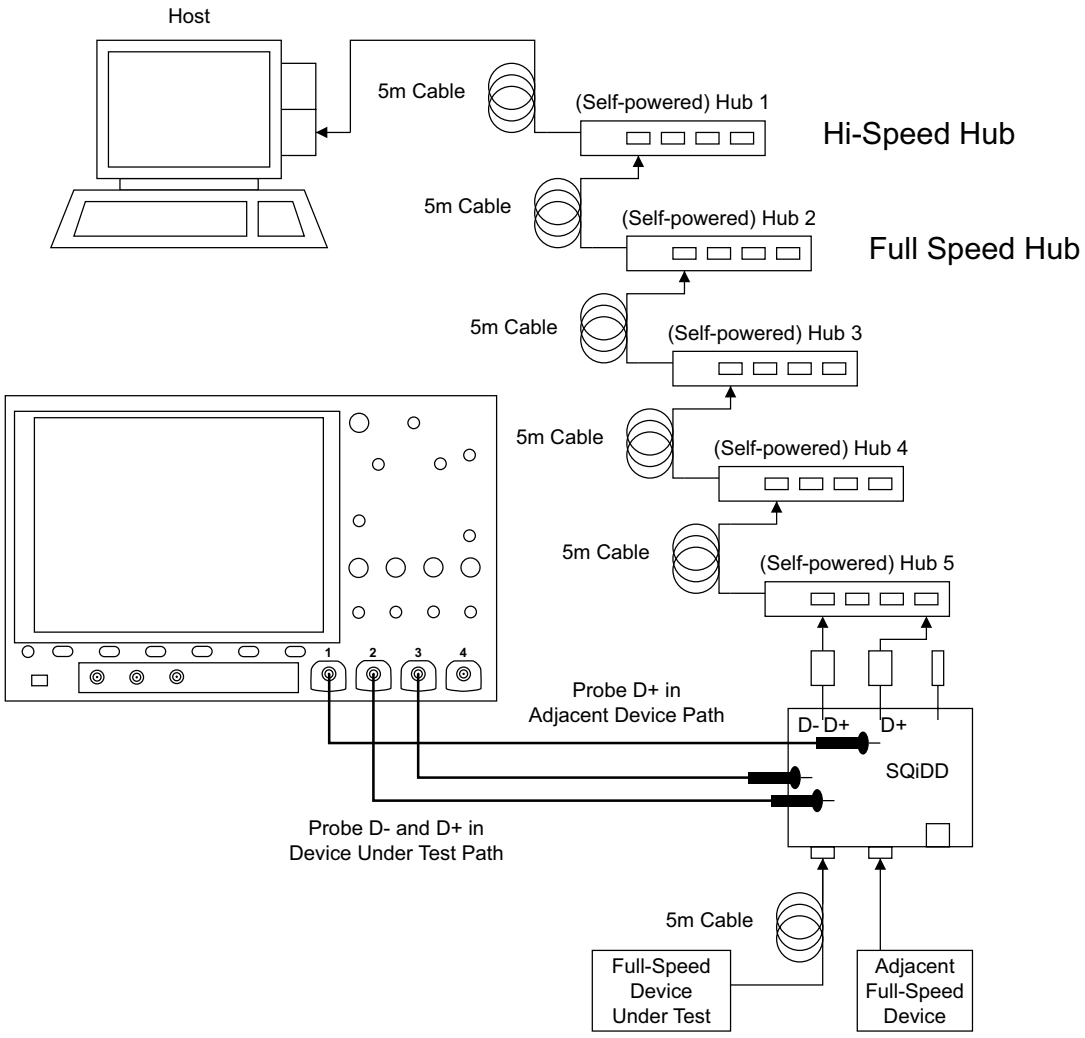
1. Attach the passive probes to the oscilloscope's Channel 2, Channel 3 and Channel 1 inputs.
2. Attach the SQiDD board to two USB ports at the end of 5 self-powered hubs and a host system. Hub #1 has to be a hi-speed hub and hub #2 has to be a full speed hub. The rest of the hubs can be either hi-speed or full speed hubs.

NOTE Placing a full speed and/or a high-speed device downstream of a full speed hub forces both to operate in full speed mode.

3. Attach a full speed device under test to the same section of the SQiDD board. If the section has a switch, it should be set to ON.
4. Attach another full speed device to the adjacent section of the SQiDD board. This is for triggering purposes.

NOTE Use a full-speed hub if device under test has embedded hub function. Otherwise the oscilloscope will falsely trigger.

5. Connect the oscilloscope Channel 2 probe to D+ probe point of the device under test portion. Connect the oscilloscope Channel 3 probe to the D- probe point of the device under test portion. Connect the oscilloscope Channel 1 probe to the D+ probe point on the adjacent device section of the SQiDD board.

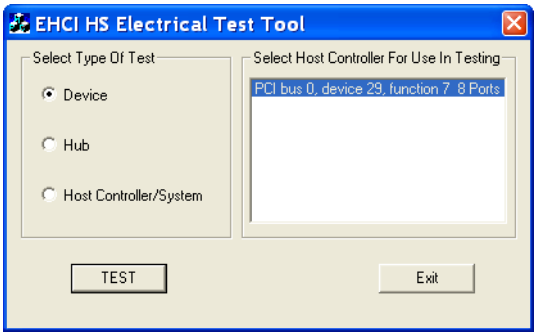


Device Full Speed Compliance Test Packets

To set up the Host computer to transmit compliance test packets, perform these steps:

1 Invoke the HS Electrical Test Tool software on the Hi-Speed Electrical Test Bed computer.

2 Select **Device** and click the **TEST** button to open the Device Test dialog box.



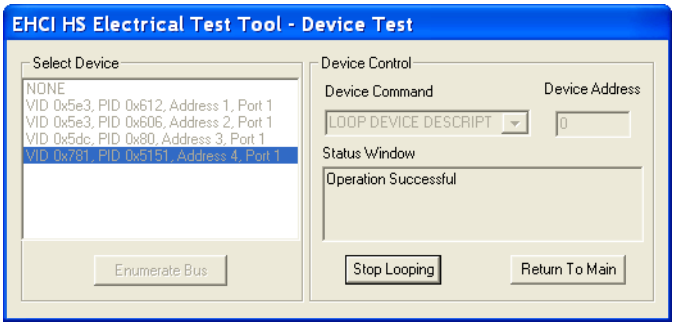
3 In the Device Test dialog box, click **Enumerate Bus** once.

All devices attached to the host controller should appear in the device enumeration list.

If you do not know which VID/PID belongs to the device under test, detach the device under test and enumerate the bus once. Then reattach the device under test and enumerate again, this time paying attention to the new device attached.

4 Highlight the device under test and select **LOOP DEVICE DESCRIPTOR** from the **Device Command** drop down menu.

5 Click **EXECUTE** once.



Device Low Speed Signal Quality Test

Table 5 Equipment Used in Upstream Low Speed Signal Quality Test

Quantity	Item	Description/Model
1	Oscilloscope	Agilent 4000 X-Series
3	Passive probes	Probes included with the oscilloscope are sufficient.
1	Host test bed computer	Any computer with the Windows XP, Windows 7, or Windows 8 operating system and hi-speed USB ports.
1	SQiDD board	Agilent E2646A/B
1	low speed USB device	Any USB mouse
5	USB self-powered hubs	Any listed on USB-IF web site
6	5 meter USB cables	Any listed on USB-IF web site

To set up and run the Device Low Speed signal quality tests:

1 Connect the USB Device, test fixtures, and equipment. See "Device Low Speed Connection" on page 35.

2 Set up the test signal/packet that will be analyzed.

   To set up the test packets used for compliance testing, see "Device Low Speed Compliance Test Packets" on page 36.

3 On the oscilloscope's front panel, press the **[Analyze]** key.

4 In the Analyze Menu, press the **Features** softkey; then, select **USB Signal Quality**.

5 Press the **Test** softkey and select the **Device Low Speed Signal Quality** test.

6 Press the **Signals** softkey. In the USB Signal Quality Signals Menu:

   a Press the **D+ Source** softkey and select the analog input source channel connected to the D+ signal (channel 2 in the previous connection instructions).

   b Press the **D- Source** softkey and select the analog input source channel connected to the D- signal (channel 3 in the previous connection instructions).

On 4-channel oscilloscopes, you are forced to use different channel pairs for the D+ and D- signals. This provides the maximum sample rate. (Channels 1 and 2 are one pair and channels 3 and 4 are the other pair.)

c Press the **Adj D- Source** softkey and select the analog input source channel connected to the adjacent D- signal (channel 1 in the previous connection instructions).

7 Press the **Auto Setup** softkey to automatically set up the oscilloscope for the selected test.

For optimal test results, you can make adjustments to the auto setup. Generally, you want one packet of data, plus the time of one bit on each end, across the oscilloscope's display. Also, vertical scale and offset should be adjusted so that the signals take six vertical divisions without being clipped.

You should see the transmitted test packet on the oscilloscope as below.

8 Press the **Run Test** softkey to run the selected signal quality test.

When tests are run, the oscilloscope stops acquisitions if they are running, analyzes the data on screen, and then displays the results.

NOTE Tests can take several minutes to run and cannot be cancelled once started.

When the test completes, the results are automatically displayed. You can press the **Display Results** softkey to disable or reenable the test results display.

The analyzed acquisition remains on screen and can be viewed by moving or dismissing the results dialog box.

You can run tests when the oscilloscope is already stopped. This is useful in the case of embedded hosts (and other cases) where the device under test (DUT) may not easily be placed in a test mode, and you want to analyze already acquired data.

See Also

- Chapter 6, “Saving Test Results to an HTML File,” starting on page 81

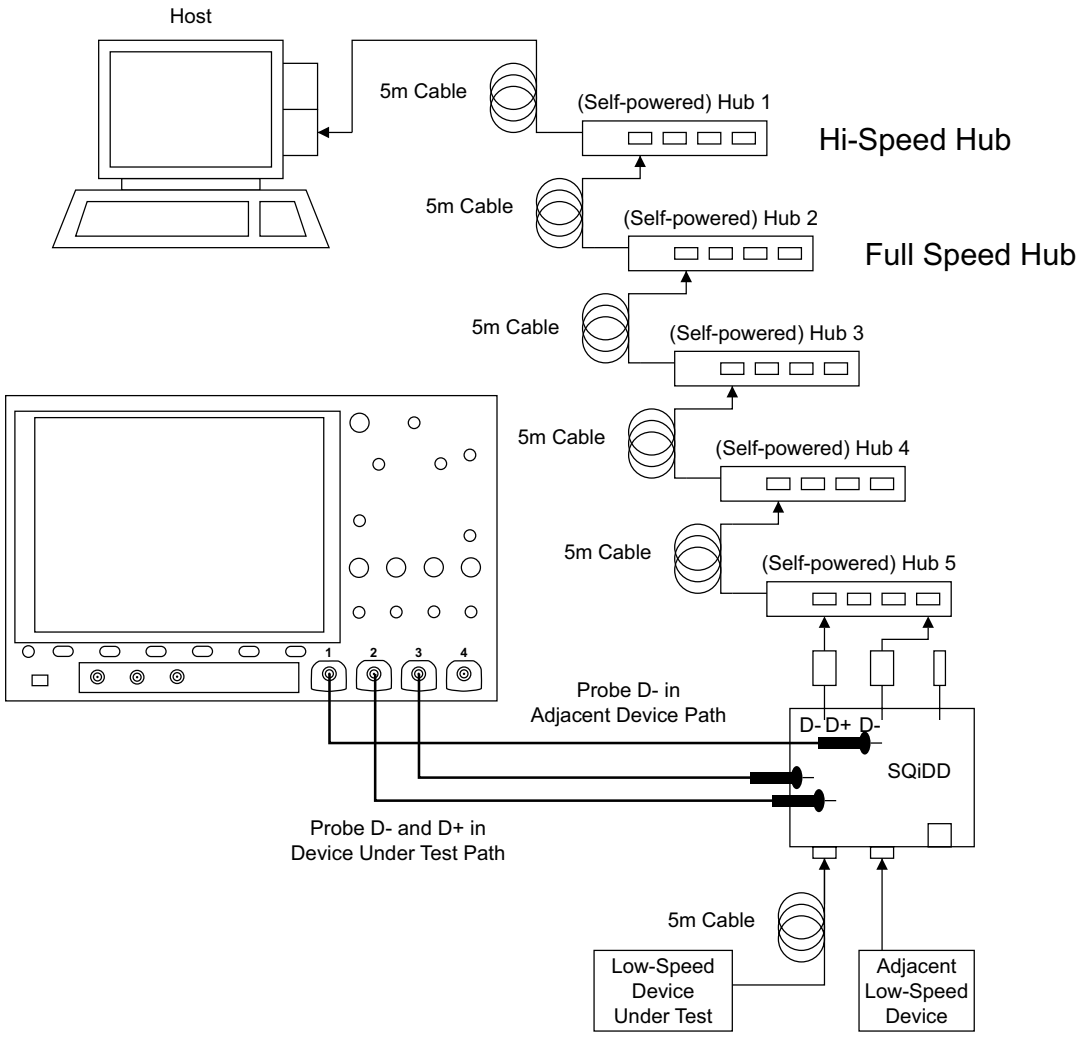
Device Low Speed Connection

Perform these connection steps:

1. Attach the passive probes to the oscilloscope's Channel 2, Channel 3 and Channel 1 inputs.
2. Attach the SQiDD board to two USB ports at the end of 5 self-powered hubs and a host system. Hub #1 has to be a hi-speed hub and hub #2 has to be a full speed hub. The rest of the hubs can be either hi-speed or full speed hubs.

NOTE Placing a full speed and/or a high-speed device downstream of a full speed hub forces both to operate in full speed mode.

3. Attach a low speed device under test to the same section of the SQiDD board. If the section has a switch, it should be set to ON.
4. Attach another low speed device to the adjacent section of the SQiDD board. This is for triggering purposes.
5. Connect the oscilloscope Channel 2 probe to D+ probe point of the device under test portion. Connect the oscilloscope Channel 3 probe to the D- probe point of the device under test portion. Connect the oscilloscope Channel 1 probe to the D- probe point on the adjacent device section of the SQiDD board.

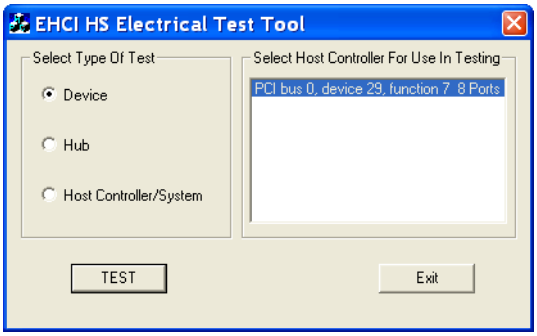


Device Low Speed Compliance Test Packets

To set up the Host computer to transmit compliance test packets, perform these steps:

1 Invoke the HS Electrical Test Tool software on the Hi-Speed Electrical Test Bed computer.

2 Select **Device** and click the **TEST** button to open the Device Test dialog box.



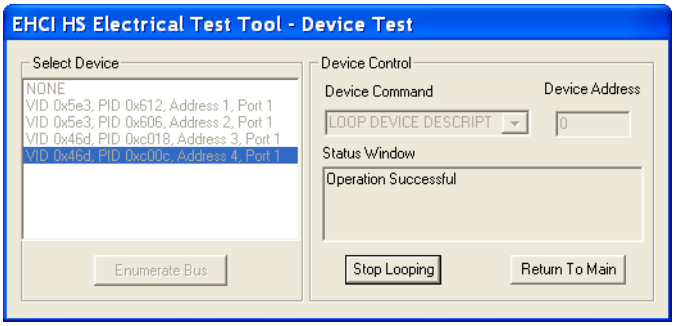
3 In the Device Test dialog box, click **Enumerate Bus** once.

All devices attached to the host controller should appear in the device enumeration list.

If you do not know which VID/PID belongs to the device under test, detach the device under test and enumerate the bus once. Then reattach the device under test and enumerate again, this time paying attention to the new device attached.

4 Highlight the device under test and select **LOOP DEVICE DESCRIPTOR** from the **Device Command** drop down menu.

5 Click **EXECUTE** once.



3 Host Signal Quality Testing

Host Hi-Speed Signal Quality Test 40
Host Full Speed Signal Quality Test 46
Host Low Speed Signal Quality Test 50

Host Hi-Speed Signal Quality Test

Table 6 Equipment Used in Host Hi-Speed Signal Quality Tests

Quantity	Item	Description/Model
1	Oscilloscope	Agilent 4000 X-Series 1.5 GHz bandwidth model
1	Oscilloscope probing solution:	
	• Differential probe	Agilent 113xA with E2678A or E2669A
	• SMA cables	Agilent 15443A matched cable pair or equivalent
1	Host test bed computer	Any computer with the Windows XP, Windows 7, or Windows 8 operating system and hi-speed USB ports.
1	Host Hi-Speed Signal Quality test fixture and 4" USB cable	Agilent E2649-66402
1	5V power supply	Agilent 0950-2546 or equivalent

To set up and run the Host Hi-Speed signal quality tests:

1 Connect the USB Device, test fixtures, and equipment:
   - If you are probing the test fixture using a differential probe, see "Host Hi-Speed Connection - Differential Probe" on page 43.
   - If you are probing the test fixture using SMA cables, see "Host Hi-Speed Connection - SMA Cables" on page 44.

2 Set up the test signal/packet that will be analyzed.

   To set up the test packets used for compliance testing, see "Host Hi-Speed Compliance Test Packets" on page 44.

3 On the oscilloscope's front panel, press the **[Analyze]** key.

4 In the Analyze Menu, press the **Features** softkey; then, select **USB Signal Quality**.

5 Press the **Test** softkey and select the **Host Hi-Speed Signal Quality** test.

6 Press the **Signals** softkey. In the USB Signal Quality Signals Menu:

   a Press the **Test Connection** softkey and select whether you are using a **Single-ended** (with SMA cables) or **Differential** probe connection.

   b If you are using a differential connection, press the **Source** softkey and select the analog input source channel connected to the differential probe.

If you are using a single-ended (SMA cables) connection, press the **DP SMA** softkey and select the analog input source channel connected to the D+ signal. Then, press the **DN SMA** softkey and select the analog input source channel connected to the D- signal.

On 4-channel oscilloscopes, you are forced to use different channel pairs for the D+ and D- signals. This provides the maximum sample rate. (Channels 1 and 2 are one pair and channels 3 and 4 are the other pair.)

Hi-Speed tests using single-ended SMA cable connections are not supported on 2-channel oscilloscopes because the sample rate does not meet the required 5 GSa/s.

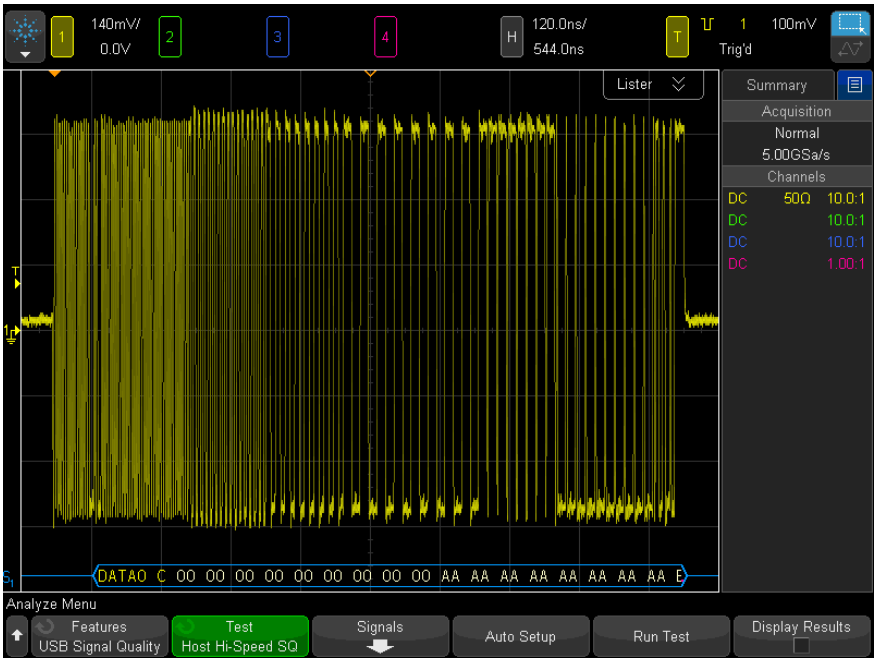
c Press the **Test Type** softkey and select **Near-end** or **Far-end**.

The terms "near-end" and "far-end" are based on which end of the cable the test fixture is attached in relation to the device being tested. The point where measurements are made dictates what eye template is used.

7 Press the **Auto Setup** softkey to automatically set up the oscilloscope for the selected test.

For optimal test results, you can make adjustments to the auto setup. Generally, you want one packet of data, plus the time of one bit on each end, across the oscilloscope's display. Also, vertical scale and offset should be adjusted so that the signals take six vertical divisions without being clipped.

You should see the transmitted test packet on the oscilloscope as below.



8 Press the **Run Test** softkey to run the selected signal quality test.

When tests are run, the oscilloscope stops acquisitions if they are running, analyzes the data on screen, and then displays the results.

NOTE Tests can take several minutes to run and cannot be cancelled once started.

When the test completes, the results are automatically displayed. You can press the **Display Results** softkey to disable or reenable the test results display.

The analyzed acquisition remains on screen and can be viewed by moving or dismissing the results dialog box.

You can run tests when the oscilloscope is already stopped. This is useful in the case of embedded hosts (and other cases) where the device under test (DUT) may not easily be placed in a test mode, and you want to analyze already acquired data.

See Also

- Chapter 6, “Saving Test Results to an HTML File,” starting on page 81

Host Hi-Speed Connection - Differential Probe

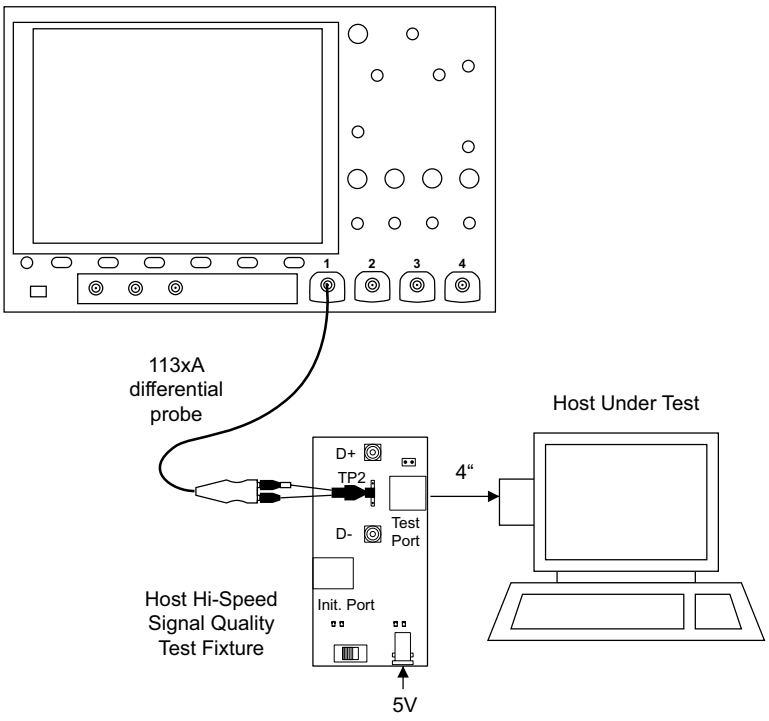
Perform these connection steps:

1 Attach the 5V power supply to J5 of the E2649-66402 Host Hi-Speed Signal Quality test fixture and verify the green POWER LED is lit.

   a Set the TEST switch (S1) of the test fixture to the ON position and verify the yellow TEST LED is lit.

2 Attach the Agilent 113xA differential probe to TP2 of the test fixture. Ensure the + polarity on the probe lines up with D+, which is the pin nearest the USB connector.

3 Please terminate the fixture's SMA connectors with 50 Ohm terminators.



4 Connect the [TEST PORT] of the E2649-66402 Host Hi-Speed Signal Quality test fixture into the port under test of the host controller, using the 4" USB cable.

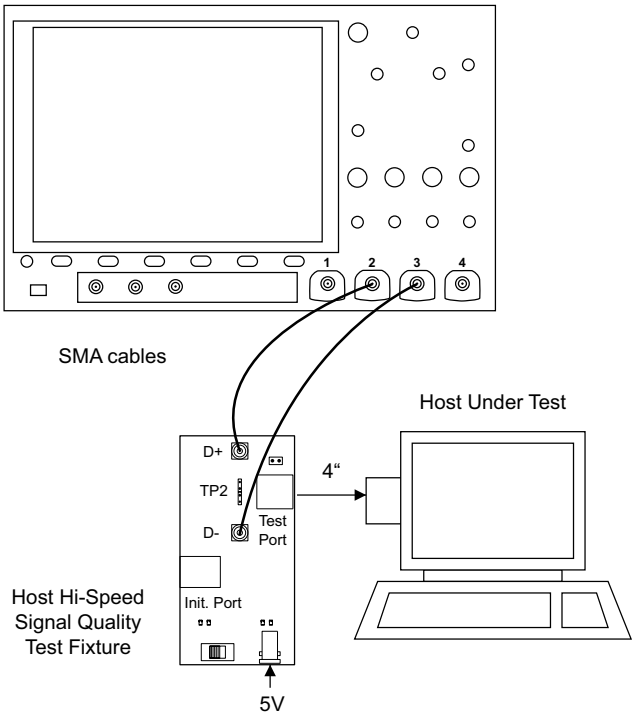
   The host controller here refers to the Hi-speed Electrical Test Bed Computer that has the HS Electrical Test Tool on it.

Host Hi-Speed Connection - SMA Cables

1 Attach the 5V power supply to J5 of the E2649-66402 Hi-Speed signal quality test fixture. Verify the green POWER LED is lit.

2 Set the TEST switch (S1) of the test fixture to the ON position and verify that the yellow TEST LED is lit.

3 Attach the SMA cables to SMA connectors D+ and D- on the test fixture.



4 Connect the [TEST PORT] of the E2649-66402 Host Hi-Speed Signal Quality test fixture into the port under test of the host controller, using the 4" USB cable.

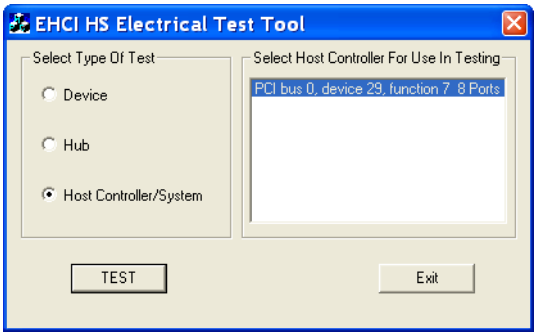
The host controller here refers to the Hi-speed Electrical Test Bed Computer that has the HS Electrical Test Tool on it.

Host Hi-Speed Compliance Test Packets

To set up the Host computer to transmit compliance test packets, perform these steps:

1 Invoke the HS Electrical Test Tool software on the Hi-Speed Electrical Test Bed computer.

2 Select **Host Controller/System** and click the **TEST** button to open the Host Test dialog box.

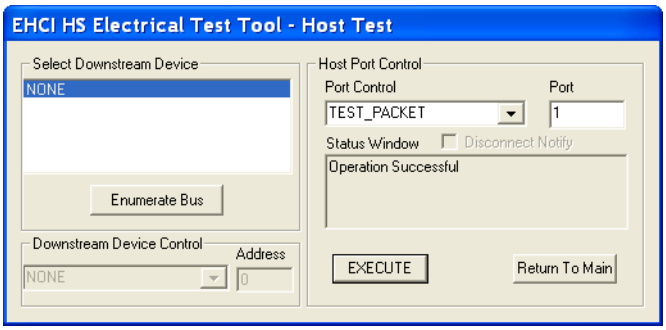


3 In the Host Test dialog box, select **TEST_PACKET** from the **Port Control** drop down menu.

4 Enter the port number of the port under test.

5 Click **EXECUTE**.

This forces the port under test to continuously transmit test packets.



Host Full Speed Signal Quality Test

Table 7 Equipment Used in Host Downstream Full Speed Signal Quality Test

Quantity	Item	Description/Model
1	Oscilloscope	Agilent 4000 X-Series
2	Passive probes	Probes included with the oscilloscope are sufficient.
1	Host test bed computer	Any computer with the Windows XP, Windows 7, or Windows 8 operating system and hi-speed USB ports.
1	SQiDD board	Agilent E2646A/B
1	full speed USB device	Intel Create and Share USB camera, P/N 735147-001, Model #: CS330
5	USB self-powered hubs	Any listed on USB-IF web site
6	5 meter USB cables	Any listed on USB-IF web site

To set up and run the Host Full Speed signal quality tests:

1 Connect the USB Device, test fixtures, and equipment. See "Host Full Speed Connection" on page 48.

2 Set up the test signal/packet that will be analyzed.

   To generate bus traffic, connect a known good Full Speed device to the port under test and capture the Full Speed SOF to perform the eye pattern analysis.

3 On the oscilloscope's front panel, press the **[Analyze]** key.

4 In the Analyze Menu, press the **Features** softkey; then, select **USB Signal Quality**.

5 Press the **Test** softkey and select the **Host Full Speed Signal Quality** test.

6 Press the **Signals** softkey. In the USB Signal Quality Signals Menu:

   a Press the **D+ Source** softkey and select the analog input source channel connected to the D+ signal (channel 2 in the previous connection instructions).

   b Press the **D- Source** softkey and select the analog input source channel connected to the D- signal (channel 3 in the previous connection instructions).

      On 4-channel oscilloscopes, you are forced to use different channel pairs for the D+ and D- signals. This provides the maximum sample rate. (Channels 1 and 2 are one pair and channels 3 and 4 are the other pair.)

When full speed tests are run on a 2-channel oscilloscope, a statement about the analysis data being under-sampled will be included in the test results.

7 Press the **Auto Setup** softkey to automatically set up the oscilloscope for the selected test.

For optimal test results, you can make adjustments to the auto setup. Generally, you want one packet of data, plus the time of one bit on each end, across the oscilloscope's display. Also, vertical scale and offset should be adjusted so that the signals take six vertical divisions without being clipped.

You should see the transmitted test packet on the oscilloscope as below.

8 Press the **Run Test** softkey to run the selected signal quality test.

When tests are run, the oscilloscope stops acquisitions if they are running, analyzes the data on screen, and then displays the results.

NOTE Tests can take several minutes to run and cannot be cancelled once started.

When the test completes, the results are automatically displayed. You can press the **Display Results** softkey to disable or reenable the test results display.

The analyzed acquisition remains on screen and can be viewed by moving or dismissing the results dialog box.

You can run tests when the oscilloscope is already stopped. This is useful in the case of embedded hosts (and other cases) where the device under test (DUT) may not easily be placed in a test mode, and you want to analyze already acquired data.

See Also

- Chapter 6, “Saving Test Results to an HTML File,” starting on page 81

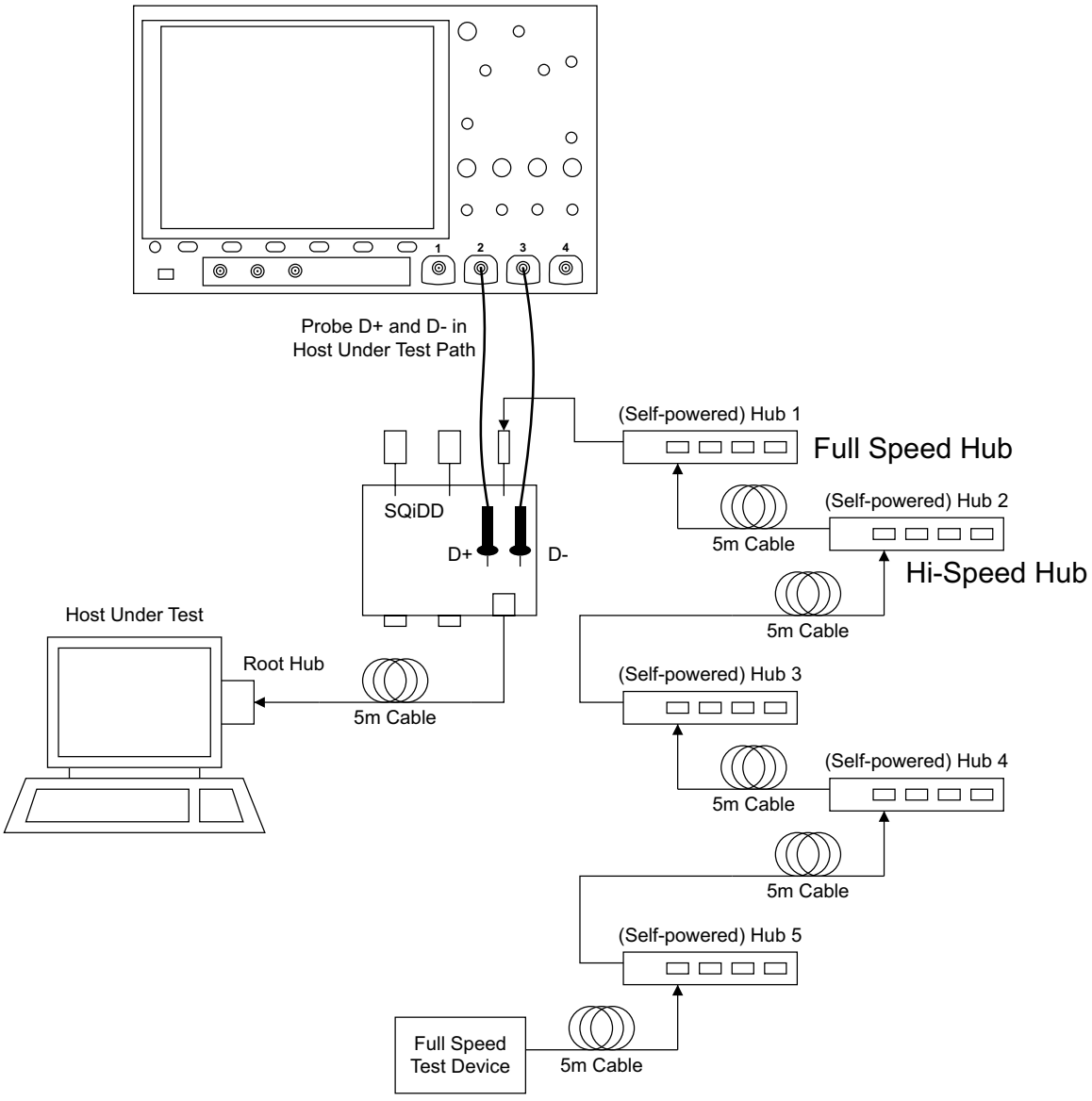
Host Full Speed Connection

Perform these connection steps:

1. Attach the passive probes to the oscilloscope's Channel 3 and Channel 2 inputs.
2. Attach the SQiDD board to the root hub on the host under test.
3. Attach 5 self-powered hubs and a full-speed device to the same section of the SQiDD board. If the section has a switch, it should be set to ON. Hub #1 has to be a full-speed hub and hub #2 a Hi-speed hub. The other hubs can be either full speed or hi-speed hubs.

NOTE Placing a full speed and/or a high-speed device downstream of a full speed hub forces both to operate in full speed mode.

4. Connect the oscilloscope Channel 2 probe to D+ probe point of the device under test portion. Connect the oscilloscope Channel 3 probe to the D- probe point of the device under test portion.
5. Exit the HS Electrical Test Tool if you have previously launched.


1
2
3
4
Probe D+ and D- in
Host Under Test Path
(Self-powered) Hub 1
Full Speed Hub
SQiDD
D+
D-
5m Cable
(Self-powered) Hub 2
Hi-Speed Hub
5m Cable
Host Under Test
Root Hub
5m Cable
(Self-powered) Hub 3
(Self-powered) Hub 4
5m Cable
5m Cable
(Self-powered) Hub 5
Full Speed
Test Device
5m Cable

Host Low Speed Signal Quality Test

Table 8 Equipment Used in Host Downstream Low Speed Signal Quality Test

Quantity	Item	Description/Model
1	Oscilloscope	Agilent 4000 X-Series
2	Passive probes	Probes included with the oscilloscope are sufficient.
1	Host test bed computer	Any computer with the Windows XP, Windows 7, or Windows 8 operating system and hi-speed USB ports.
1	SQiDD board	Agilent E2646A/B
1	low speed USB device	Any USB mouse

To set up and run the Host Low Speed signal quality tests:

1 Connect the USB Device, test fixtures, and equipment. See "Host Low Speed Connection" on page 52.

2 Set up the test signal/packet that will be analyzed.

   To generate bus traffic, connect a known good Low Speed device to the port under test and capture a Low Speed packet to perform the eye pattern analysis.

3 On the oscilloscope's front panel, press the **[Analyze]** key.

4 In the Analyze Menu, press the **Features** softkey; then, select **USB Signal Quality**.

5 Press the **Test** softkey and select the **Host Low Speed Signal Quality** test.

6 Press the **Signals** softkey. In the USB Signal Quality Signals Menu:

   a Press the **D+ Source** softkey and select the analog input source channel connected to the D+ signal (channel 2 in the previous connection instructions).

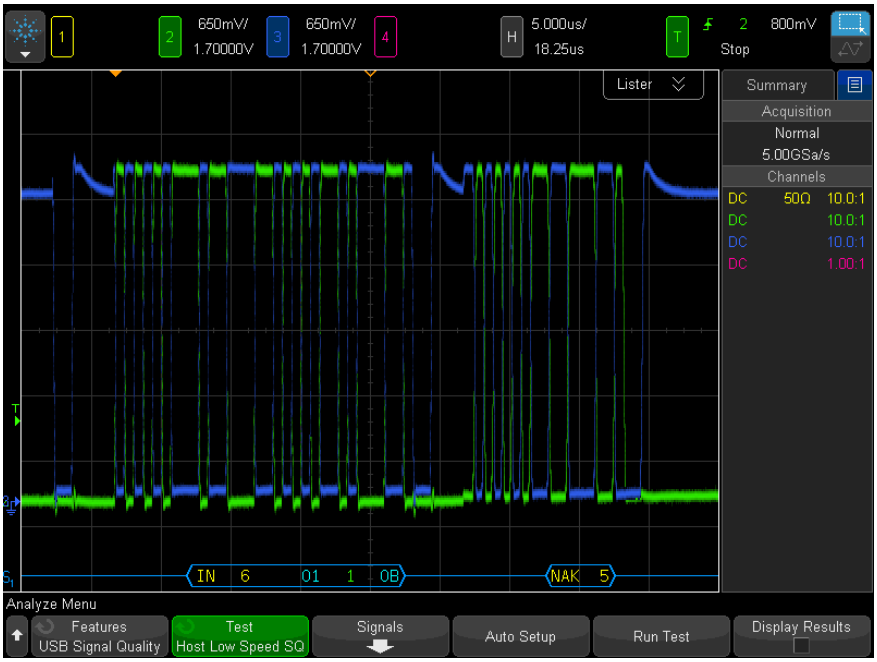
   b Press the **D- Source** softkey and select the analog input source channel connected to the D- signal (channel 3 in the previous connection instructions).

      On 4-channel oscilloscopes, you are forced to use different channel pairs for the D+ and D- signals. This provides the maximum sample rate. (Channels 1 and 2 are one pair and channels 3 and 4 are the other pair.)

7 Press the **Auto Setup** softkey to automatically set up the oscilloscope for the selected test.

For optimal test results, you can make adjustments to the auto setup. Generally, you want one packet of data, plus the time of one bit on each end, across the oscilloscope's display. Also, vertical scale and offset should be adjusted so that the signals take six vertical divisions without being clipped.

You should see the transmitted test packet on the oscilloscope as below.



8 Press the **Run Test** softkey to run the selected signal quality test.

When tests are run, the oscilloscope stops acquisitions if they are running, analyzes the data on screen, and then displays the results.

NOTE Tests can take several minutes to run and cannot be cancelled once started.

When the test completes, the results are automatically displayed. You can press the **Display Results** softkey to disable or reenable the test results display.

The analyzed acquisition remains on screen and can be viewed by moving or dismissing the results dialog box.

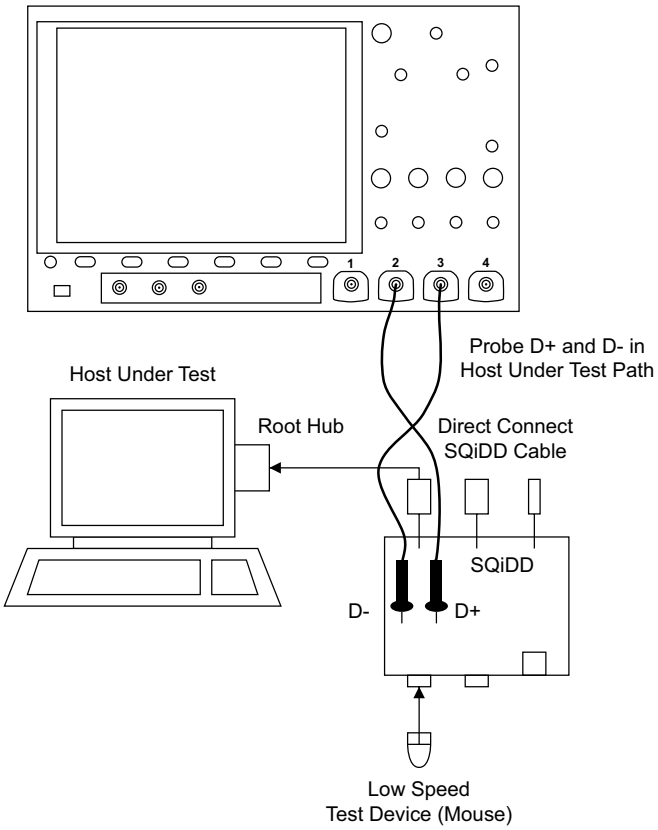
You can run tests when the oscilloscope is already stopped. This is useful in the case of embedded hosts (and other cases) where the device under test (DUT) may not easily be placed in a test mode, and you want to analyze already acquired data.

See Also • Chapter 6, “Saving Test Results to an HTML File,” starting on page 81

Host Low Speed Connection

Perform these connection steps:

1. Use the passive probes included with the oscilloscope.
2. Attach the passive probes to the oscilloscope's Channel 3 and Channel 2 inputs.
3. Attach the SQiDD board to the root hub on the host under test.
4. Attach a low speed device to the same section of the SQiDD board. If the section has a switch, it should be set to ON.
5. Connect the oscilloscope Channel 2 probe to D+ probe point on the SQiDD board. Connect the oscilloscope Channel 3 probe to the D- probe point on the SQiDD board.
6. Exit the HS Electrical Test Tool if you have previously launched it.



4 Hub Upstream Signal Quality Testing

Hub Upstream Hi-Speed Signal Quality Test 54
Hub Upstream Full Speed Signal Quality Test 60

Hub Upstream Hi-Speed Signal Quality Test

Table 9 Equipment Used in Hub Hi-Speed Signal Quality Test - Upstream Facing Ports

Quantity	Item	Description/Model
1	Oscilloscope	Agilent 4000 X-Series 1.5 GHz bandwidth model
1	Oscilloscope probing solution:	
	• Differential probe	Agilent 113xA with E2678A or E2669A
	• SMA cables	Agilent 15443A matched cable pair or equivalent
1	Host test bed computer	Any computer with the Windows XP, Windows 7, or Windows 8 operating system and hi-speed USB ports.
1	Device Hi-Speed Signal Quality test fixture and 4" USB cable	Agilent E2649-66401
1	5V power supply	Agilent 0950-2546 or equivalent

To set up and run the Hub upstream Hi-Speed signal quality tests:

1 Connect the USB Device, test fixtures, and equipment:
   - If you are probing the test fixture using a differential probe, see "Hub Upstream Hi-Speed Connection - Differential Probe" on page 57.
   - If you are probing the test fixture using SMA cables, see "Hub Upstream Hi-Speed Connection - SMA Cables" on page 58.

2 Set up the test signal/packet that will be analyzed.

   To set up the test packets used for compliance testing, see "Hub Upstream Hi-Speed Compliance Test Packets" on page 59.

3 On the Device Hi-Speed Signal Quality test fixture, place the TEST switch (S1) in the ON position.

   Verify the yellow TEST LED is lit.

4 On the oscilloscope's front panel, press the **[Analyze]** key.

5 In the Analyze Menu, press the **Features** softkey; then, select **USB Signal Quality**.

6 Press the **Test** softkey and select the **Device Hi-Speed Signal Quality** test.

7 Press the **Signals** softkey. In the USB Signal Quality Signals Menu:

   a Press the **Test Connection** softkey and select whether you are using a **Single-ended** (with SMA cables) or **Differential** probe connection.

   b If you are using a differential connection, press the **Source** softkey and select the analog input source channel connected to the differential probe.

      If you are using a single-ended (SMA cables) connection, press the **DP SMA** softkey and select the analog input source channel connected to the D+ signal. Then, press the **DN SMA** softkey and select the analog input source channel connected to the D- signal.

      On 4-channel oscilloscopes, you are forced to use different channel pairs for the D+ and D- signals. This provides the maximum sample rate. (Channels 1 and 2 are one pair and channels 3 and 4 are the other pair.)

      Hi-Speed tests using single-ended SMA cable connections are not supported on 2-channel oscilloscopes because the sample rate does not meet the required 5 GSa/s.

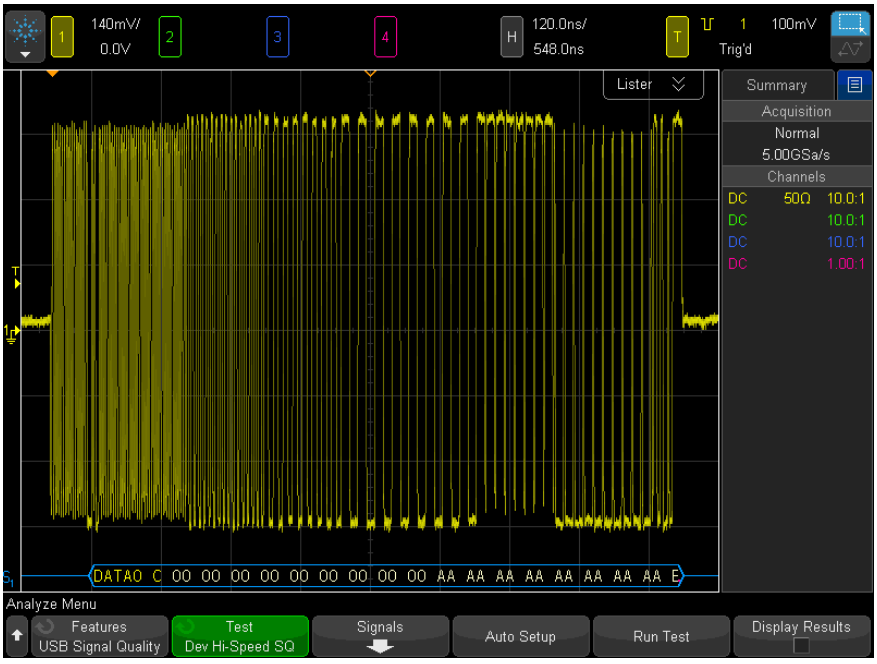
   c Press the **Test Type** softkey and select **Near-end** or **Far-end**.

      The terms "near-end" and "far-end" are based on which end of the cable the test fixture is attached in relation to the device being tested. The point where measurements are made dictates what eye template is used.

8 Press the **Auto Setup** softkey to automatically set up the oscilloscope for the selected test.

   For optimal test results, you can make adjustments to the auto setup. Generally, you want one packet of data, plus the time of one bit on each end, across the oscilloscope's display. Also, vertical scale and offset should be adjusted so that the signals take six vertical divisions without being clipped.

   You should see the transmitted test packet on the oscilloscope as below.



9 Press the **Run Test** softkey to run the selected signal quality test.

When tests are run, the oscilloscope stops acquisitions if they are running, analyzes the data on screen, and then displays the results.

NOTE Tests can take several minutes to run and cannot be cancelled once started.

When the test completes, the results are automatically displayed. You can press the **Display Results** softkey to disable or reenable the test results display.

The analyzed acquisition remains on screen and can be viewed by moving or dismissing the results dialog box.

You can run tests when the oscilloscope is already stopped. This is useful in the case of embedded hosts (and other cases) where the device under test (DUT) may not easily be placed in a test mode, and you want to analyze already acquired data.

See Also

- Chapter 6, “Saving Test Results to an HTML File,” starting on page 81

Hub Upstream Hi-Speed Connection - Differential Probe

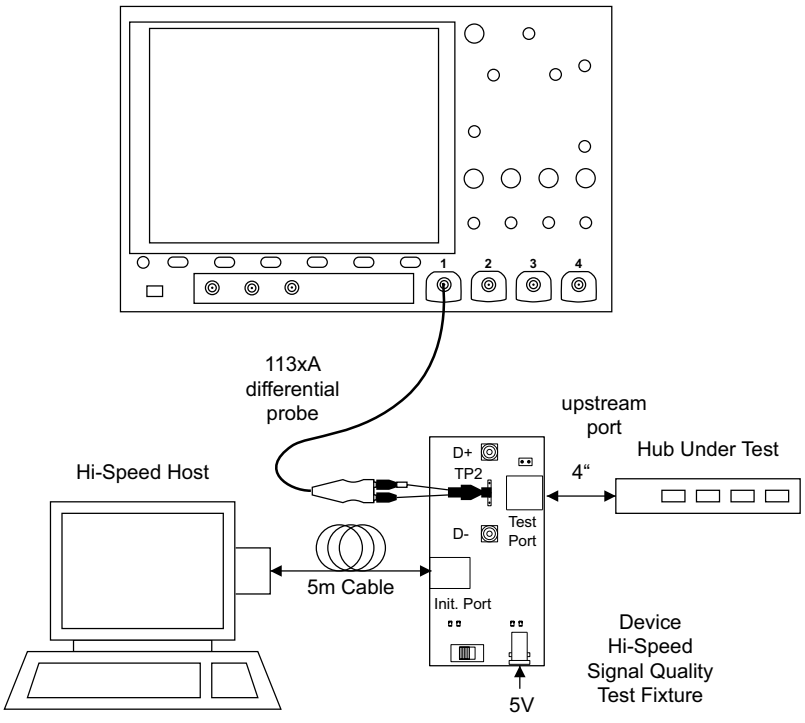
Perform these connection steps:

1. Attach the 5V power supply to J5 of the E2649-66401 Device Hi-Speed Signal Quality test fixture.

   Leave the TEST switch at the OFF position.

   Verify green POWER LED is lit, and yellow TEST LED is off.

2. Connect the [TEST PORT] of the test fixture into the upstream facing port of the hub under test, using the 4" USB cable.
3. Connect the [INIT PORT] of the test fixture to a hi-speed port of the Test Bed Computer. Apply power to the hub.
4. Attach the Agilent 113xA differential probe to D+/D- of TP2 on the test fixture. Ensure the + polarity on the probe lines up with D+ on the fixture.
5. Please terminate the fixture's SMA connectors with 50 Ohm terminators.



Hub Upstream Hi-Speed Connection - SMA Cables

1 Attach the 5V power supply to J5 of the E2649-66401 Device Hi-Speed signal quality test fixture.

Leave the TEST switch at the OFF position.

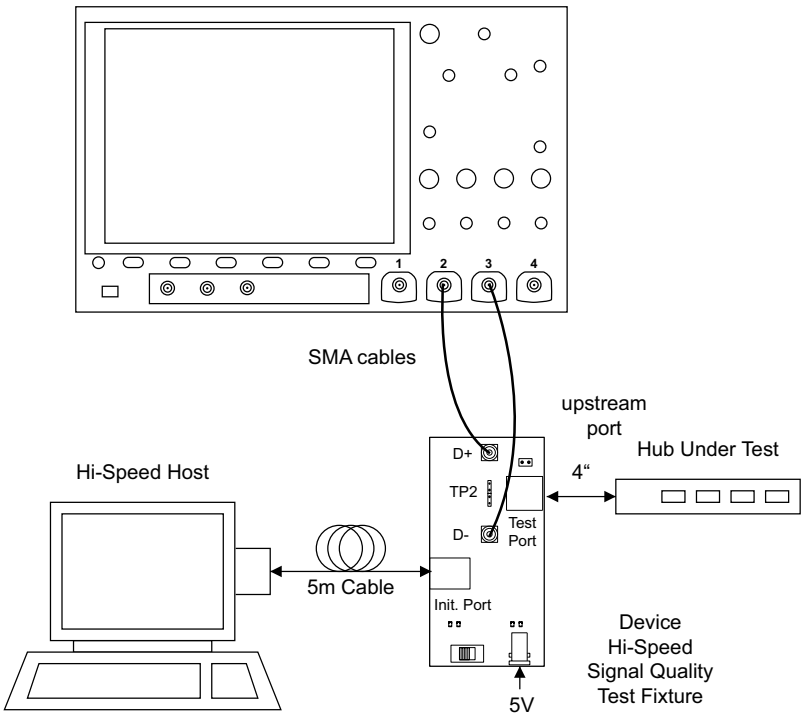
Verify the green POWER LED is lit and the yellow TEST LED is not lit.

2 Connect the [TEST PORT] of the Device Hi-speed Signal Quality test fixture into the upstream facing port of the device under test, using the 4" USB cable.

3 Connect the [INIT PORT] of the test fixture to a Hi-speed capable port of the Test Bed Computer, using the 5 meter USB cable.

4 Apply power to the device.

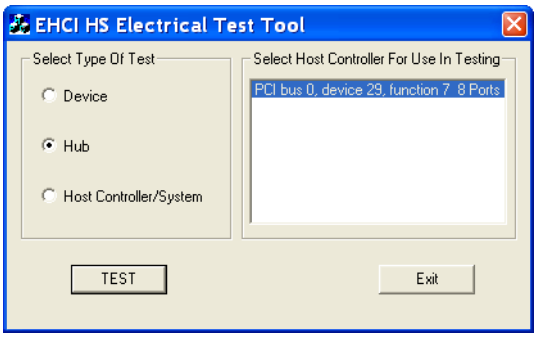
5 Attach the SMA cables to the SMA connectors D+ and D- of TP2 on the test fixture.



Hub Upstream Hi-Speed Compliance Test Packets

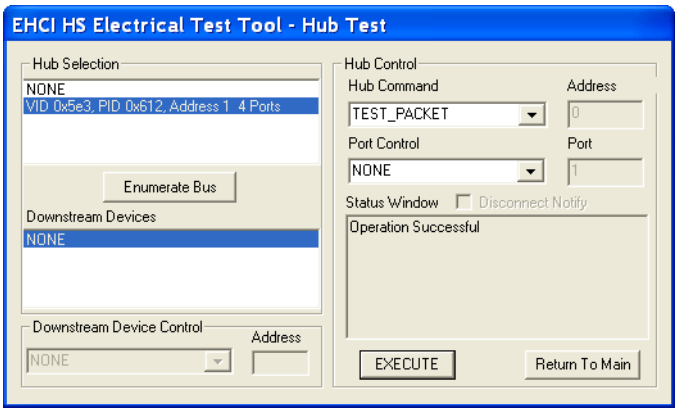
To set up the Host computer to transmit compliance test packets, perform these steps:

1 Invoke the HS Electrical Test Tool software on the Hi-Speed Electrical Test Bed computer. Select **Hub** and click the **TEST** button to enter the Hub Test dialog box.



2 In the Hub Test dialog box, the hub under test should be enumerated with the hub's VID shown together with the USB address.

Select **TEST_PACKET** from the **Hub Command** drop down menu.



3 Click **EXECUTE**.

Hub Upstream Full Speed Signal Quality Test

Table 10 Equipment Used in Upstream Full Speed Signal Quality Test

Quantity	Item	Description/Model
1	Oscilloscope	Agilent 4000 X-Series
3	Passive probes	Probes included with the oscilloscope are sufficient.
1	Host test bed computer	Any computer with the Windows XP, Windows 7, or Windows 8 operating system and hi-speed USB ports.
1	SQiDD board	Agilent E2646A/B
1	full speed USB device	Intel Create and Share USB camera, P/N 735147-001, Model #: CS330
5	USB self-powered hubs	Any listed on USB-IF web site
6	5 meter USB cables	Any listed on USB-IF web site

To set up and run the Hub upstream Full Speed signal quality tests:

1 Connect the USB Device, test fixtures, and equipment. See "Hub Upstream Full Speed Connection" on page 62.

2 Set up the test signal/packet that will be analyzed.

   To set up the test packets used for compliance testing, see "Hub Upstream Full Speed Compliance Test Packets" on page 63.

3 On the oscilloscope's front panel, press the **[Analyze]** key.

4 In the Analyze Menu, press the **Features** softkey; then, select **USB Signal Quality**.

5 Press the **Test** softkey and select the **Device Full Speed Signal Quality** test.

6 Press the **Signals** softkey. In the USB Signal Quality Signals Menu:

   a Press the **D+ Source** softkey and select the analog input source channel connected to the D+ signal (channel 2 in the previous connection instructions).

   b Press the **D- Source** softkey and select the analog input source channel connected to the D- signal (channel 3 in the previous connection instructions).

      On 4-channel oscilloscopes, you are forced to use different channel pairs for the D+ and D- signals. This provides the maximum sample rate. (Channels 1 and 2 are one pair and channels 3 and 4 are the other pair.)

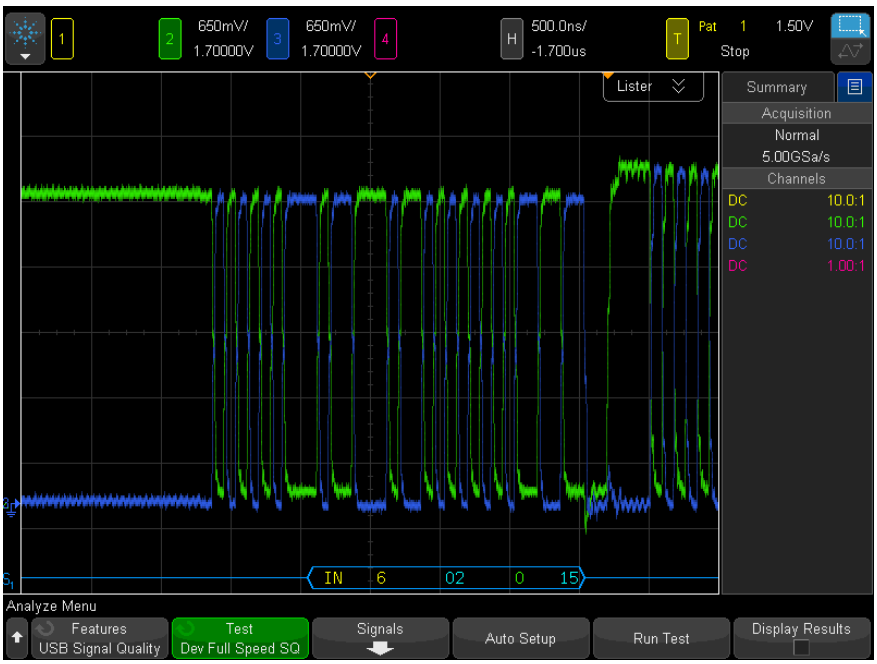
When full speed tests are run on a 2-channel oscilloscope, a statement about the analysis data being under-sampled will be included in the test results.

c Press the **Adj D+ Source** softkey and select the analog input source channel connected to the adjacent D+ signal

7 Press the **Auto Setup** softkey to automatically set up the oscilloscope for the selected test.

For optimal test results, you can make adjustments to the auto setup. Generally, you want one packet of data, plus the time of one bit on each end, across the oscilloscope's display. Also, vertical scale and offset should be adjusted so that the signals take six vertical divisions without being clipped.

You should see the transmitted test packet on the oscilloscope as below.



8 Press the **Run Test** softkey to run the selected signal quality test.

When tests are run, the oscilloscope stops acquisitions if they are running, analyzes the data on screen, and then displays the results.

NOTE Tests can take several minutes to run and cannot be cancelled once started.

When the test completes, the results are automatically displayed. You can press the **Display Results** softkey to disable or reenable the test results display.

The analyzed acquisition remains on screen and can be viewed by moving or dismissing the results dialog box.

You can run tests when the oscilloscope is already stopped. This is useful in the case of embedded hosts (and other cases) where the device under test (DUT) may not easily be placed in a test mode, and you want to analyze already acquired data.

See Also
- Chapter 6, “Saving Test Results to an HTML File,” starting on page 81

Hub Upstream Full Speed Connection

Perform these connection steps:

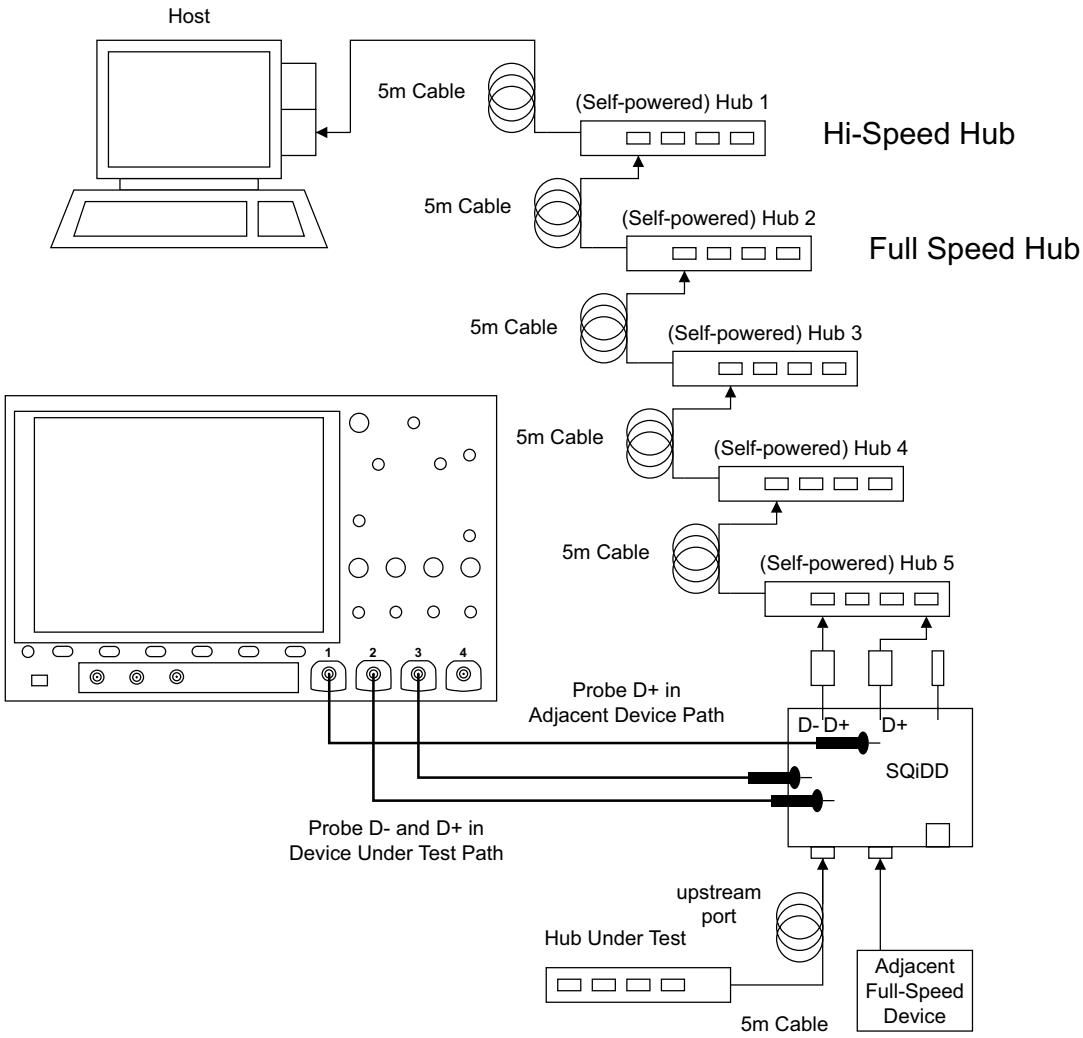
1. Attach the passive probes to the oscilloscope's channel Channel 2, Channel 3 and Channel 1 inputs.
2. Attach the SQiDD board to two USB ports at the end of 5 self-powered hubs and a host system. Hub #1 has to be a hi-speed hub and hub #2 has to be a full speed hub. The rest of the hubs can be either hi-speed or full speed hubs.

NOTE Placing a full speed and/or a high-speed device downstream of a full speed hub forces both to operate in full speed mode.

3. Attach a full speed hub under test to the same section of the SQiDD board. If the section has a switch, it should be set to ON.
4. Attach another full speed device to the adjacent section of the SQiDD board. This is for triggering purposes.

NOTE Use a full-speed hub if device under test has embedded hub function. Otherwise the oscilloscope will falsely trigger.

5. Connect the oscilloscope Channel 2 probe to D+ probe point of the hub under test portion. Connect the oscilloscope Channel 3 probe to the D- probe point of the hub under test portion. Connect the oscilloscope Channel 1 probe to the D+ probe point on the adjacent device section of the SQiDD board.

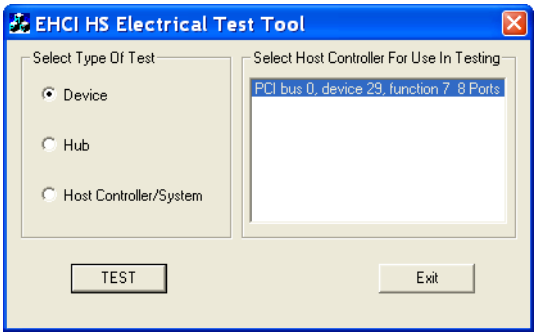


Hub Upstream Full Speed Compliance Test Packets

To set up the Host computer to transmit compliance test packets, perform these steps:

1 Invoke the HS Electrical Test Tool software on the Hi-Speed Electrical Test Bed computer.

2 Select **Device** and click the **TEST** button to open the Device Test dialog box.



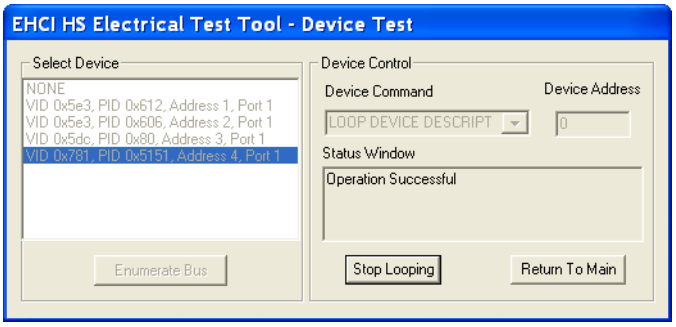
3 In the Device Test dialog box, click **Enumerate Bus** once.

All devices attached to the host controller should appear in the device enumeration list.

If you do not know which VID/PID belongs to the device under test, detach the device under test and enumerate the bus once. Then reattach the device under test and enumerate again, this time paying attention to the new device attached.

4 Highlight the hub under test and select **LOOP DEVICE DESCRIPTOR** from the **Device Command** drop down menu.

5 Click **EXECUTE** once.



5 Hub Downstream Signal Quality Testing

Hub Downstream Hi-Speed Signal Quality Test 66
Hub Downstream Full Speed Signal Quality Test 72
Hub Downstream Low Speed Signal Quality Test 76

Hub Downstream Hi-Speed Signal Quality Test

Table 11 Equipment Used in Hub Hi-Speed Signal Quality Test - Downstream Facing Ports

Quantity	Item	Description/Model
1	Oscilloscope	Agilent 4000 X-Series 1.5 GHz bandwidth model
1	Oscilloscope probing solution:	
	• Differential probe	Agilent 113xA with E2678A or E2669A
	• SMA cables	Agilent 15443A matched cable pair or equivalent
1	Host test bed computer	Any computer with the Windows XP, Windows 7, or Windows 8 operating system and hi-speed USB ports.
1	Host Hi-Speed Signal Quality test fixture and 4" USB cable	Agilent E2649-66402
1	5V power supply	Agilent 0950-2546 or equivalent

To set up and run the Hub downstream Hi-Speed signal quality tests:

1 Connect the USB Device, test fixtures, and equipment:
   - If you are probing the test fixture using a differential probe, see "Hub Downstream Hi-Speed Connection - Differential Probe" on page 69.
   - If you are probing the test fixture using SMA cables, see "Hub Downstream Hi-Speed Connection - SMA Cables" on page 70.

2 Set up the test signal/packet that will be analyzed.

   To set up the test packets used for compliance testing, see "Hub Downstream Hi-Speed Compliance Test Packets" on page 71.

3 On the oscilloscope's front panel, press the **[Analyze]** key.

4 In the Analyze Menu, press the **Features** softkey; then, select **USB Signal Quality**.

5 Press the **Test** softkey and select the **Host Hi-Speed Signal Quality** test.

6 Press the **Signals** softkey. In the USB Signal Quality Signals Menu:

   a Press the **Test Connection** softkey and select whether you are using a **Single-ended** (with SMA cables) or **Differential** probe connection.

   b If you are using a differential connection, press the **Source** softkey and select the analog input source channel connected to the differential probe.

If you are using a single-ended (SMA cables) connection, press the **DP SMA** softkey and select the analog input source channel connected to the D+ signal. Then, press the **DN SMA** softkey and select the analog input source channel connected to the D- signal.

On 4-channel oscilloscopes, you are forced to use different channel pairs for the D+ and D- signals. This provides the maximum sample rate. (Channels 1 and 2 are one pair and channels 3 and 4 are the other pair.)

Hi-Speed tests using single-ended SMA cable connections are not supported on 2-channel oscilloscopes because the sample rate does not meet the required 5 GSa/s.

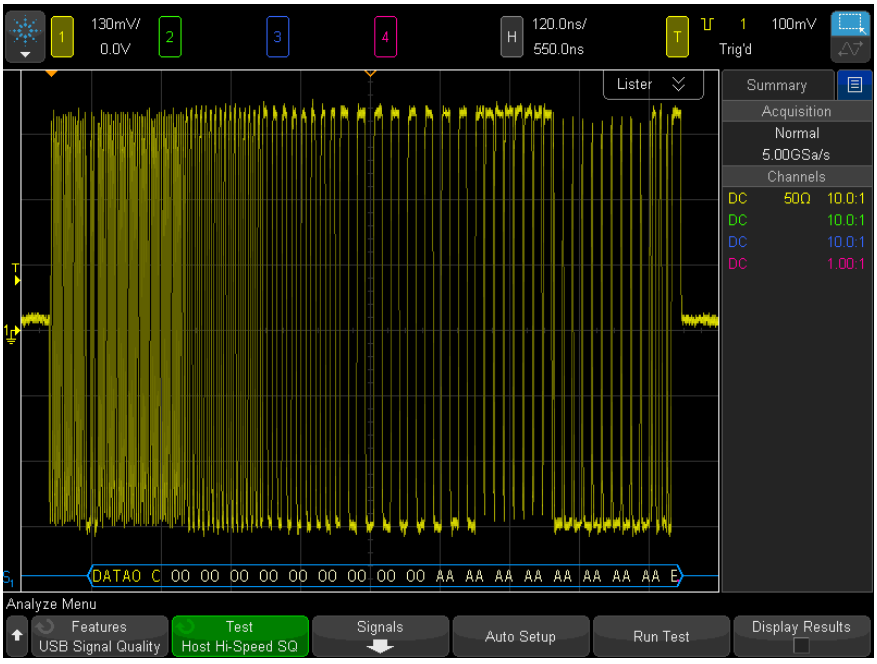
c Press the **Test Type** softkey and select **Near-end** or **Far-end**.

The terms "near-end" and "far-end" are based on which end of the cable the test fixture is attached in relation to the device being tested. The point where measurements are made dictates what eye template is used.

7 Press the **Auto Setup** softkey to automatically set up the oscilloscope for the selected test.

For optimal test results, you can make adjustments to the auto setup. Generally, you want one packet of data, plus the time of one bit on each end, across the oscilloscope's display. Also, vertical scale and offset should be adjusted so that the signals take six vertical divisions without being clipped.

You should see the transmitted test packet on the oscilloscope as below.



8 Press the **Run Test** softkey to run the selected signal quality test.

When tests are run, the oscilloscope stops acquisitions if they are running, analyzes the data on screen, and then displays the results.

NOTE Tests can take several minutes to run and cannot be cancelled once started.

When the test completes, the results are automatically displayed. You can press the **Display Results** softkey to disable or reenable the test results display.

The analyzed acquisition remains on screen and can be viewed by moving or dismissing the results dialog box.

You can run tests when the oscilloscope is already stopped. This is useful in the case of embedded hosts (and other cases) where the device under test (DUT) may not easily be placed in a test mode, and you want to analyze already acquired data.

See Also

- Chapter 6, “Saving Test Results to an HTML File,” starting on page 81

Hub Downstream Hi-Speed Connection - Differential Probe

Perform these connection steps:

1 Attach the 5V power supply to J5 of the E2649-66402 Host Hi-Speed Signal Quality test fixture.

Set the Test switch to the TEST position.

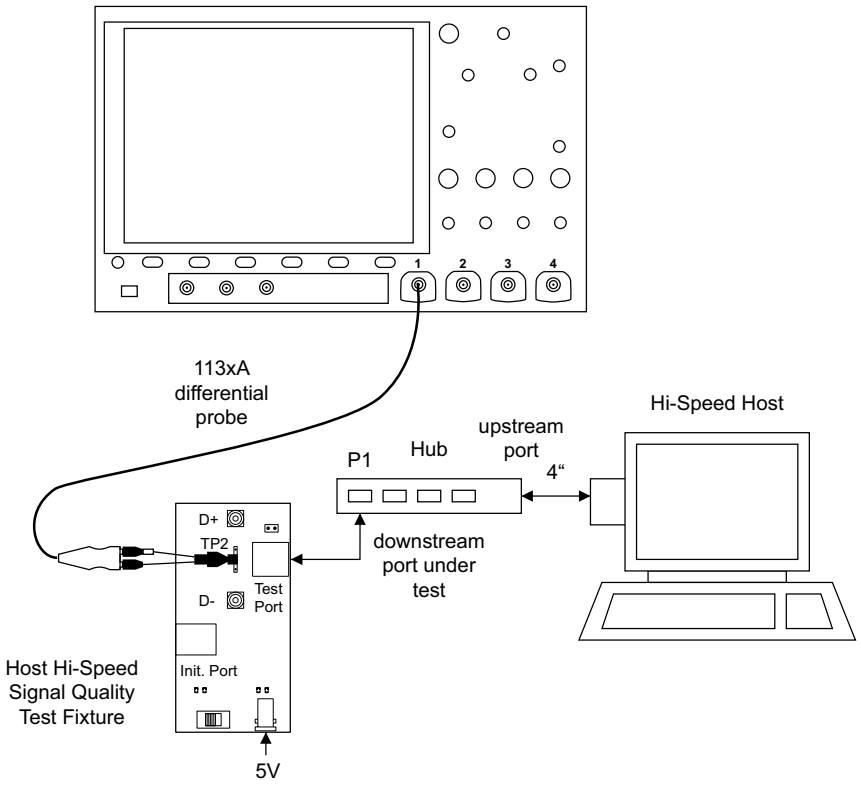
Verify green POWER LED and yellow TEST LED are both lit.

2 Attach the Agilent 113xA differential probe to TP2 of the test fixture. Ensure the + polarity on the probe lines up with D+ on the fixture, located nearest to the USB connector.

3 Connect the upstream port of the hub to a high-speed root port of the test bed computer.

4 Connect the [TEST PORT] of the test fixture into the down stream facing port under the test of the hub. Apply power to the hub.

5 Please terminate the fixture's SMA connectors with 50 Ohm terminators.



Hub Downstream Hi-Speed Connection - SMA Cables

Perform these connection steps:

1 Attach the 5V power supply to J5 of the E2649-66402 Host Hi-Speed Signal Quality test fixture.

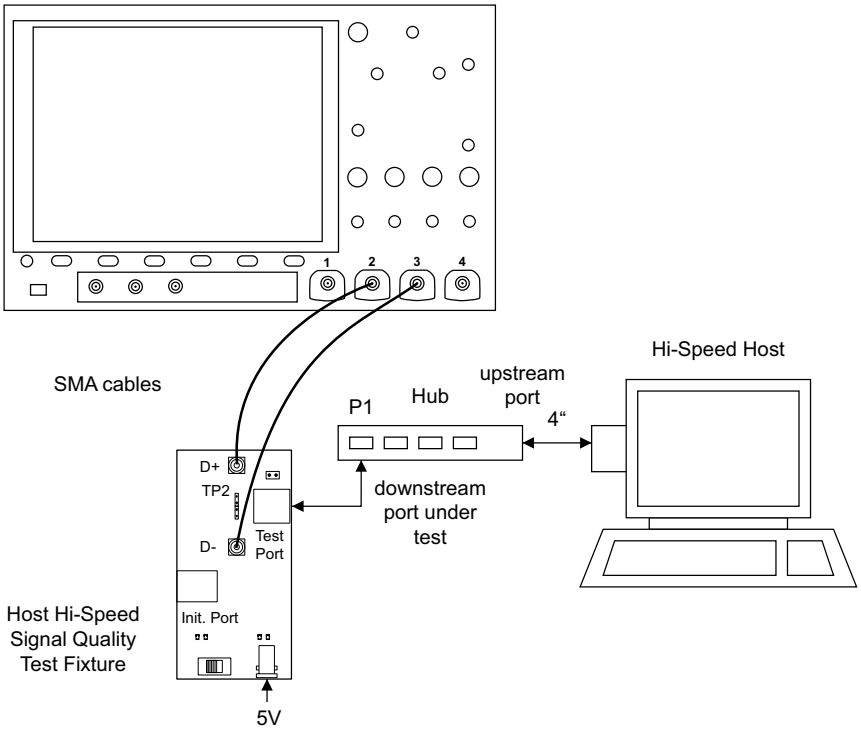
Set the TEST switch to the ON position.

Verify green POWER LED and yellow TEST LED are both lit.

2 Connect the upstream port of the hub to a high-speed root port of the test bed computer.

3 Connect the [TEST PORT] of the test fixture into the down stream facing port under the test of the hub. Apply power to the hub.

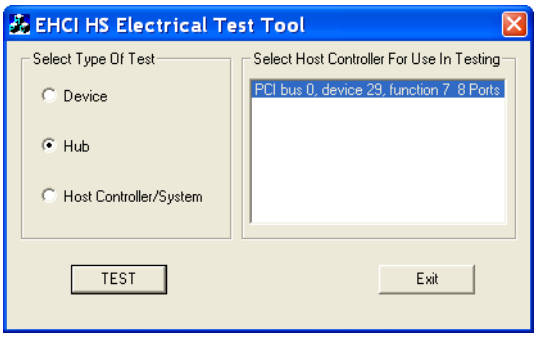
4 Attach the SMA cables to the SMA connectors D+ and D- of TP2 on the test fixture.



Hub Downstream Hi-Speed Compliance Test Packets

To set up the Host computer to transmit compliance test packets, perform these steps:

1 Invoke the HS Electrical Test Tool software on the Hi-Speed Electrical Test Bed computer. Select **Hub** and click the **TEST** button to enter the Hub Test dialog box.

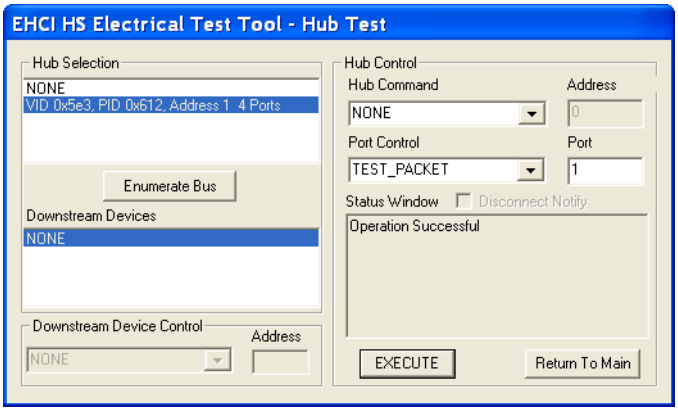


2 In the Hub Test dialog box, click the **Enumerate Bus** button once.

The hub under test should be enumerated with the hub's VID shown together with the USB address.

3 Select **TEST_PACKET** from the **Port Control** drop down menu.

4 Enter the port number of the hub port being tested.



5 Click **EXECUTE**.

Hub Downstream Full Speed Signal Quality Test

Table 12 Equipment Used in Hub Downstream Full Speed Signal Quality Test

Quantity	Item	Description/Model
1	Oscilloscope	Agilent 4000 X-Series
2	Passive probes	Probes included with the oscilloscope are sufficient.
1	Host test bed computer	Any computer with the Windows XP, Windows 7, or Windows 8 operating system and hi-speed USB ports.
1	SQiDD board	Agilent E2646A/B
1	full speed USB device	Intel Create and Share USB camera, P/N 735147-001, Model #: CS330
5	USB self-powered hubs	Any listed on USB-IF web site
6	5 meter USB cables	Any listed on USB-IF web site

To set up and run the Host Full Speed signal quality tests:

1 Connect the USB Device, test fixtures, and equipment. See "Hub Downstream Full Speed Connection" on page 74.

2 Set up the test signal/packet that will be analyzed.

Hubs produce downstream signals that can be tested. Connect a known good Full Speed device to the hub under test and capture the Full Speed SOF to perform the eye pattern analysis.

3 On the oscilloscope's front panel, press the **[Analyze]** key.

4 In the Analyze Menu, press the **Features** softkey; then, select **USB Signal Quality**.

5 Press the **Test** softkey and select the **Host Full Speed Signal Quality** test.

6 Press the **Signals** softkey. In the USB Signal Quality Signals Menu:

a Press the **D+ Source** softkey and select the analog input source channel connected to the D+ signal (channel 2 in the previous connection instructions).

b Press the **D- Source** softkey and select the analog input source channel connected to the D- signal (channel 3 in the previous connection instructions).

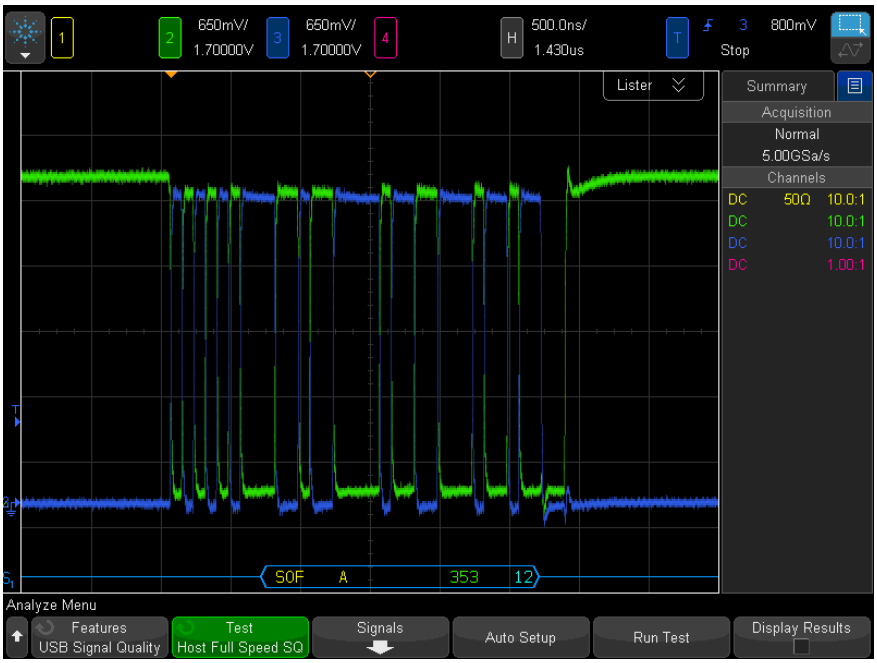
On 4-channel oscilloscopes, you are forced to use different channel pairs for the D+ and D- signals. This provides the maximum sample rate. (Channels 1 and 2 are one pair and channels 3 and 4 are the other pair.)

When full speed tests are run on a 2-channel oscilloscope, a statement about the analysis data being under-sampled will be included in the test results.

7 Press the **Auto Setup** softkey to automatically set up the oscilloscope for the selected test.

For optimal test results, you can make adjustments to the auto setup. Generally, you want one packet of data, plus the time of one bit on each end, across the oscilloscope's display. Also, vertical scale and offset should be adjusted so that the signals take six vertical divisions without being clipped.

You should see the transmitted test packet on the oscilloscope as below.



8 Press the **Run Test** softkey to run the selected signal quality test.

When tests are run, the oscilloscope stops acquisitions if they are running, analyzes the data on screen, and then displays the results.

NOTE Tests can take several minutes to run and cannot be cancelled once started.

When the test completes, the results are automatically displayed. You can press the **Display Results** softkey to disable or reenable the test results display.

The analyzed acquisition remains on screen and can be viewed by moving or dismissing the results dialog box.

You can run tests when the oscilloscope is already stopped. This is useful in the case of embedded hosts (and other cases) where the device under test (DUT) may not easily be placed in a test mode, and you want to analyze already acquired data.

See Also

- Chapter 6, “Saving Test Results to an HTML File,” starting on page 81

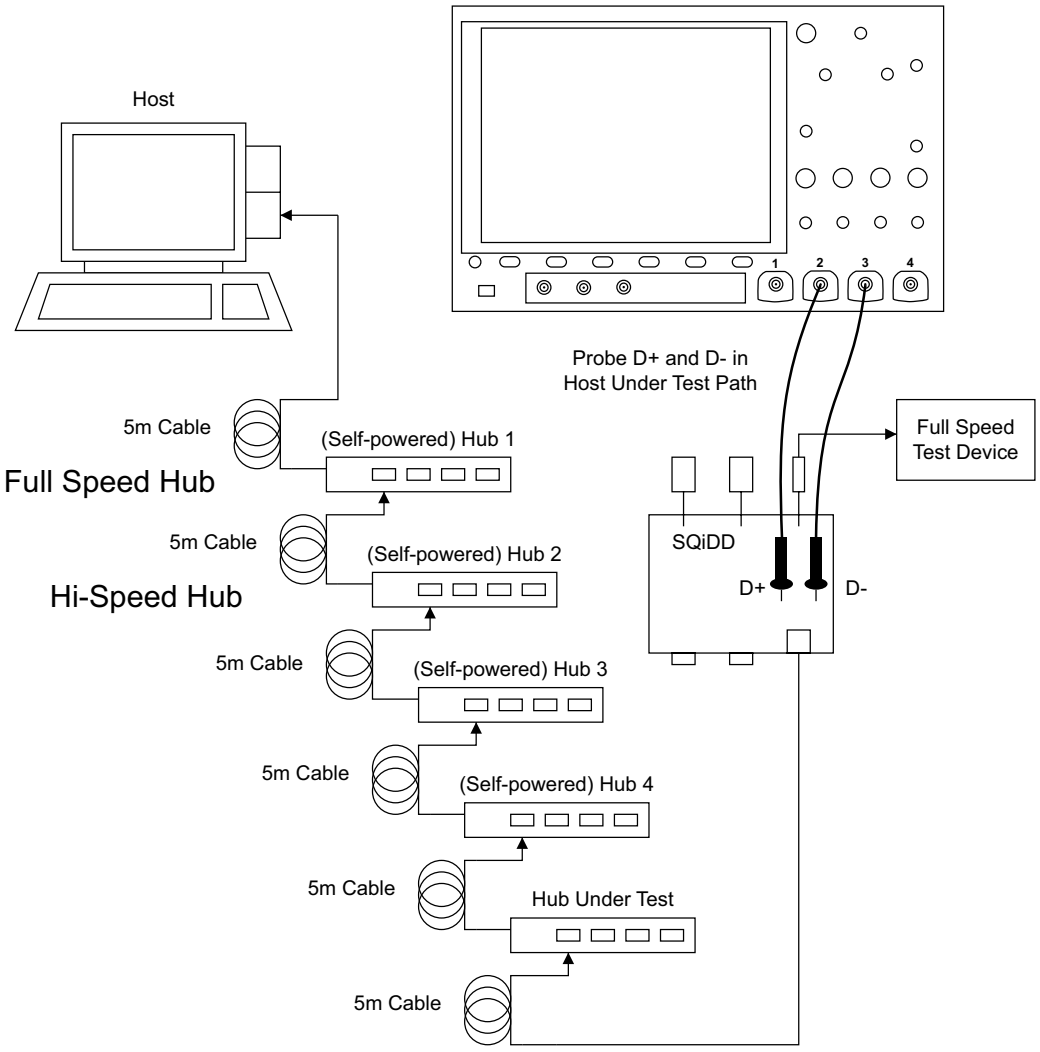
Hub Downstream Full Speed Connection

Perform these connection steps:

1. Attach the passive probes to the oscilloscope's Channel 3 and Channel 2 inputs.
2. Attach the SQiDD board to the hub under test.
3. Attach the upstream port of the hub under test to the end of 4 self-powered hubs and a host system. Hub #1 has to be a full-speed hub and hub #2 a Hi-speed hub. The other hubs can be either full speed or hi-speed hubs.

NOTE Placing a full speed and/or a high-speed device downstream of a full speed hub forces both to operate in full speed mode.

4. Attach a full speed device to the same section of the SQiDD board. If the section has a switch, it should be set to ON.
5. Connect the oscilloscope Channel 2 probe to D+ probe point of the device under test portion. Connect the oscilloscope channel Channel 3 probe to the D- probe point of the device under test portion.
6. Exit the HS Electrical Test Tool if you have previously launched it.


Host
1
2
3
4
Probe D+ and D- in
Host Under Test Path
Full Speed
Test Device
5m Cable
(Self-powered) Hub 1
Full Speed Hub
SQiDD
5m Cable
(Self-powered) Hub 2
D+
D-
Hi-Speed Hub
5m Cable
(Self-powered) Hub 3
5m Cable
(Self-powered) Hub 4
5m Cable
Hub Under Test
5m Cable

Hub Downstream Low Speed Signal Quality Test

Table 13 Equipment Used in Hub Downstream Low Speed Signal Quality Test

Quantity	Item	Description/Model
1	Oscilloscope	Agilent 4000 X-Series
2	Passive probes	Probes included with the oscilloscope are sufficient.
1	Host test bed computer	Any computer with the Windows XP, Windows 7, or Windows 8 operating system and hi-speed USB ports.
1	SQiDD board	Agilent E2646A/B
1	low speed USB device	Any USB mouse
5	USB self-powered hubs	Any listed on USB-IF web site
5	5 meter USB cables	Any listed on USB-IF web site

To set up and run the Hub downstream Low Speed signal quality tests:

1 Connect the USB Device, test fixtures, and equipment. See "Hub Downstream Low Speed Connection" on page 78.

2 Set up the test signal/packet that will be analyzed.

Hubs produce downstream signals that can be tested. Connect a known good Low Speed device to the hub under test and capture a Low Speed packet to perform the eye pattern analysis.

3 On the oscilloscope's front panel, press the **[Analyze]** key.

4 In the Analyze Menu, press the **Features** softkey; then, select **USB Signal Quality**.

5 Press the **Test** softkey and select the **Host Low Speed Signal Quality** test.

6 Press the **Signals** softkey. In the USB Signal Quality Signals Menu:

a Press the **D+ Source** softkey and select the analog input source channel connected to the D+ signal (channel 2 in the previous connection instructions).

b Press the **D- Source** softkey and select the analog input source channel connected to the D- signal (channel 3 in the previous connection instructions).

On 4-channel oscilloscopes, you are forced to use different channel pairs for the D+ and D- signals. This provides the maximum sample rate. (Channels 1 and 2 are one pair and channels 3 and 4 are the other pair.)

7 Press the **Auto Setup** softkey to automatically set up the oscilloscope for the selected test.

For optimal test results, you can make adjustments to the auto setup. Generally, you want one packet of data, plus the time of one bit on each end, across the oscilloscope's display. Also, vertical scale and offset should be adjusted so that the signals take six vertical divisions without being clipped.

You should see the transmitted test packet on the oscilloscope as below.

8 Press the **Run Test** softkey to run the selected signal quality test.

When tests are run, the oscilloscope stops acquisitions if they are running, analyzes the data on screen, and then displays the results.

NOTE Tests can take several minutes to run and cannot be cancelled once started.

When the test completes, the results are automatically displayed. You can press the **Display Results** softkey to disable or reenable the test results display.

The analyzed acquisition remains on screen and can be viewed by moving or dismissing the results dialog box.

You can run tests when the oscilloscope is already stopped. This is useful in the case of embedded hosts (and other cases) where the device under test (DUT) may not easily be placed in a test mode, and you want to analyze already acquired data.

See Also

- Chapter 6, “Saving Test Results to an HTML File,” starting on page 81

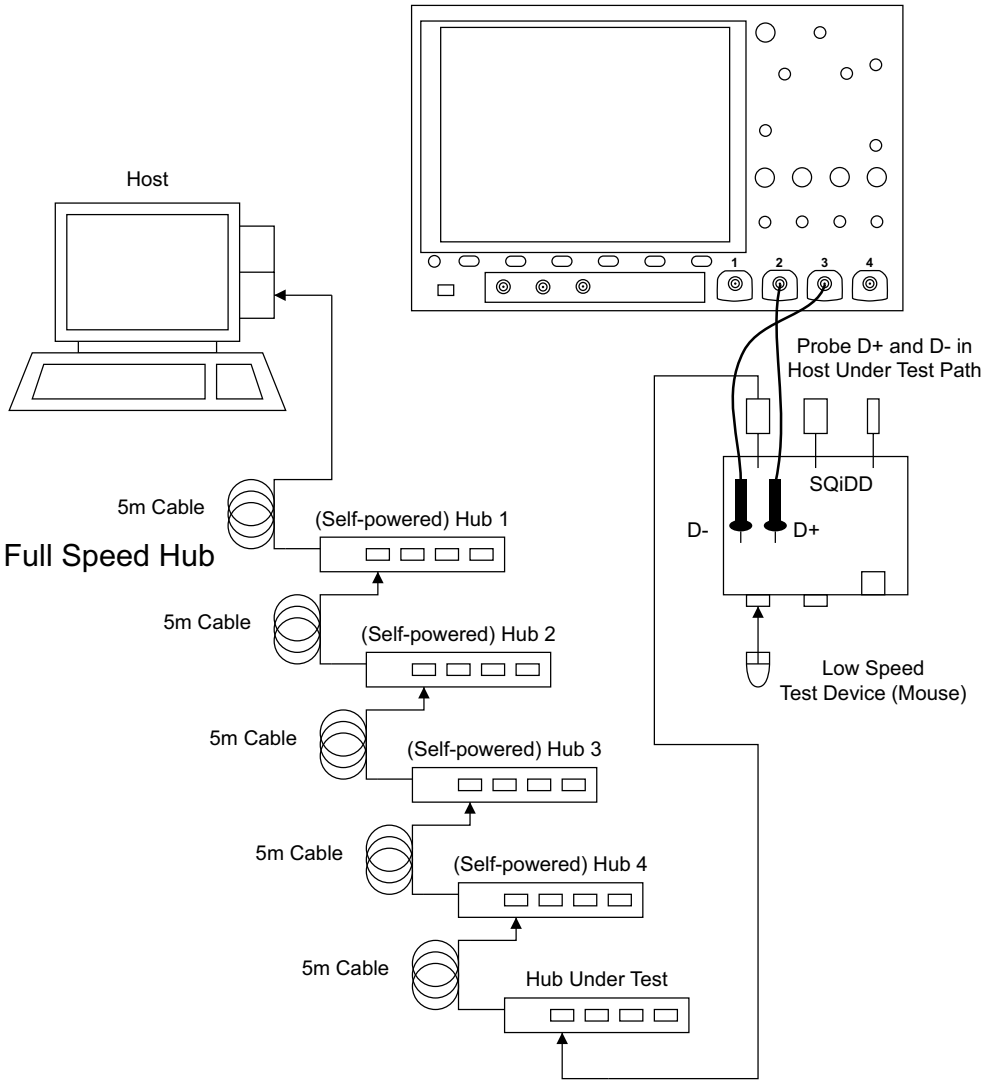
Hub Downstream Low Speed Connection

Perform these connection steps:

1. Use the passive probes included with the oscilloscope.
2. Attach the passive probes to the oscilloscope's Channel 3 and Channel 2 inputs.
3. Attach the SQiDD board to the hub under test.
4. Attach the upstream port of the hub under test to the end of 4 self-powered hubs and a host system. Hub #1 has to be a full speed hub. The other hubs can be either full speed or hi-speed hubs.

NOTE The best method to capture and analyze low-speed downstream signal quality is to capture both a keep-alive (low speed EOP) if present and a SOF packet. Hubs are required to generate keep-alives when there is full speed traffic and pass them on to low speed devices.

5. Attach a low speed device to the same section of the SQiDD board. If the section has a switch, it should be set to ON.
6. Connect the oscilloscope Channel 2 probe to D+ probe point of the device under test portion. Connect the oscilloscope Channel 3 probe to the D- probe point of the device under test portion.
7. Exit the HS Electrical Test Tool if you have previously launched it.


Host
1
2
3
4
Probe D+ and D- in
Host Under Test Path
SQiDD
D-
D+
5m Cable
(Self-powered) Hub 1
Full Speed Hub
5m Cable
(Self-powered) Hub 2
5m Cable
(Self-powered) Hub 3
5m Cable
(Self-powered) Hub 4
5m Cable
Hub Under Test
Low Speed
Test Device (Mouse)

6 Saving Test Results to an HTML File

To save USB 2.0 signal quality test results:

1. Connect a USB storage device to one of the oscilloscope's USB Host ports.
2. On the oscilloscope's front panel, press **[Save/Recall]** > **Save** > **Format** and select the **USB Signal Quality** option.
3. Press the second softkey; then, use the File Explorer to browse to the location where you want to save the test results file.
4. Press the **File Name** softkey and specify the name of the test results file.
5. Press the **Press to Save** softkey.

NOTE You can also e-mail test results by pressing **[Save/Recall]** > **Email** and using the softkeys in the **Email Menu**.

A
Probing Hi-Speed Signals with InfiniiMode Using SQiDD as a Feedthrough

If you need a feed-through that will let you probe Hi-Speed signals with the N2750A Series InfiniiMode probe, you can use the E2646A/B SQiDD test fixture (normally used for Full and Low Speed testing) and InfiniiMode probes.

Use the center section of the board as the feed-though. Probe the signals using the test points.

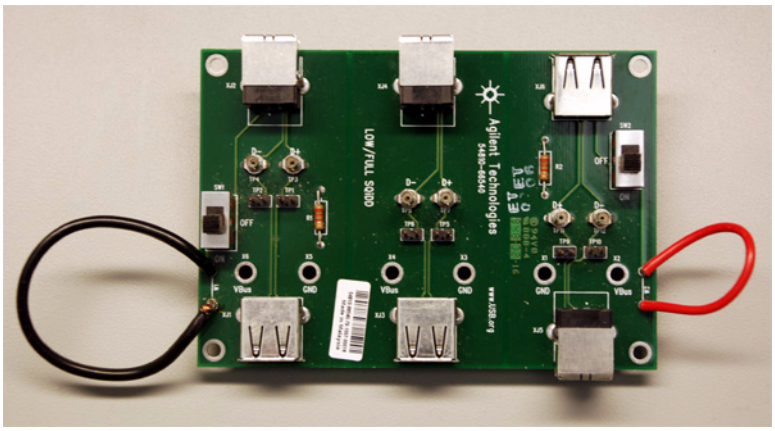


Figure 2 E2646A/B SQiDD Board

A Probing Hi-Speed Signals with InfiniiMode Using SQiDD as a Feedthrough

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